GUIDE LEAFLET 1975-C and 1976-B

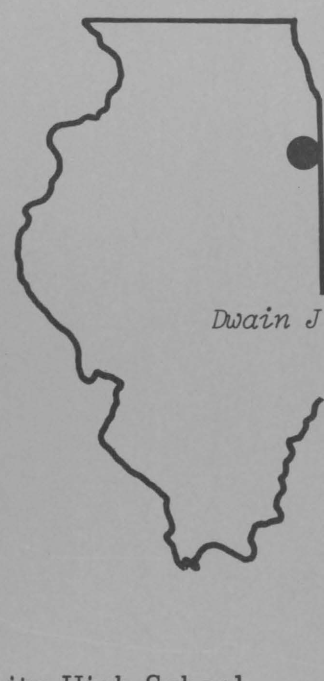
GUIDE LEAFLET

GEOLOGICAL SCIENCE FIELD TRIP

ST. ANNE - MOMENCE AREA

Kankakee County

Kankakee and Momence 15-Minute Quadrangles



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Host— St. Anne Community High School

October 4, 1975

May 22, 1976

Sponsored by the

ILLINOIS STATE GEOLOGICAL SURVEY

Urbana 61801

TO THE PARTICIPANTS:

The Geological Science Field Trip program is designed to acquaint Illinois residents with the landscape, the rock and mineral resources, and the geological processes that have led to their origin. With this program, we hope to stimulate a general interest in the geology of Illinois and a greater appreciation of the state's vast mineral resources and their importance to the over-all economy.

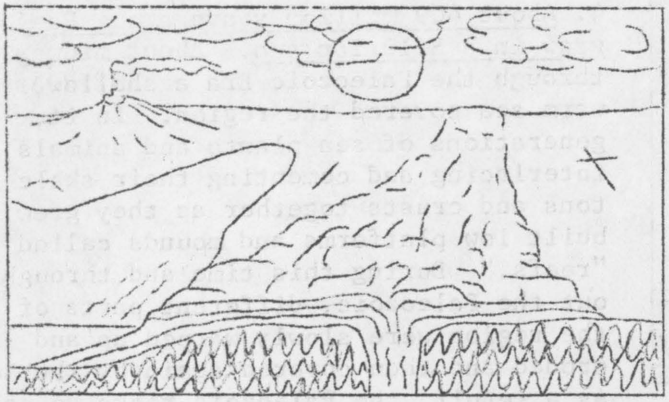
We encourage you to ask the tour leaders any questions that may occur to you during the trip. Discussion often clarifies points that otherwise would remain confused to many of the participants. We also invite your written comments upon the conduct of the trips so that we might improve them as much as possible.

Additional copies of this guide leaflet, as well as itineraries for field trips that have been held in the past, may be obtained free of charge by writing to the Illinois State Geological Survey. The itinerary maps for each field trip can be purchased for 10 cents each.

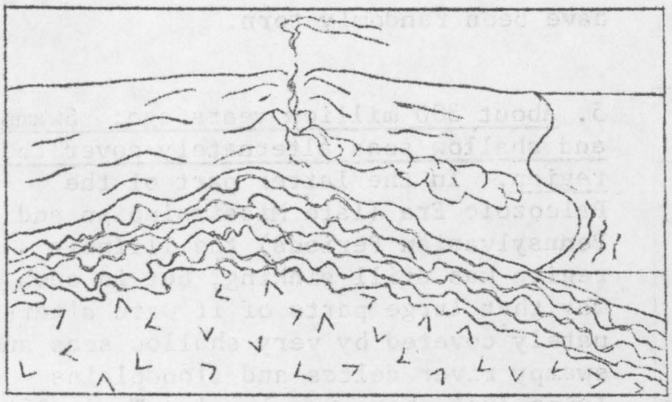
Several of the stops along this itinerary are located on private property whose owners have graciously given us permission to visit their lands. Please obey the instructions of your trip leaders and conduct yourselves in a manner that will show respect for the property owners' cooperation. Please do not litter, or climb on fences, and leave all gates as found, so that we may be welcome to return on future field trips. These simple rules of courtesy also apply to public property as well. For the convenience of those persons who may use this itinerary at some future time, the names and addresses of every private property owner are listed for the respective stops on a page at the back of this guide leaflet. Whenever possible, always attempt to obtain permission when visiting private property.

We hope that you enjoy today's field trip and will attend others in the future.

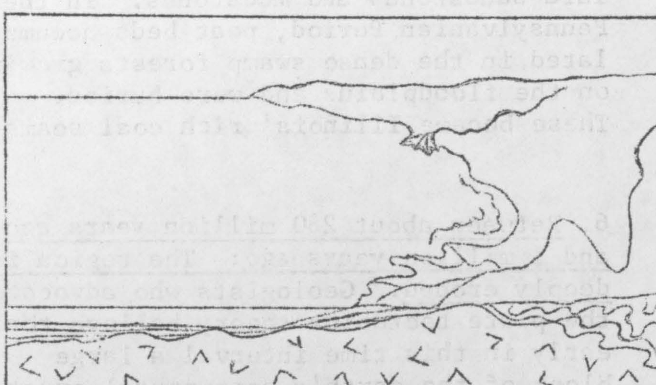
THE STAFF
EDUCATIONAL EXTENSION SECTION
ILLINOIS STATE GEOLOGICAL SURVEY



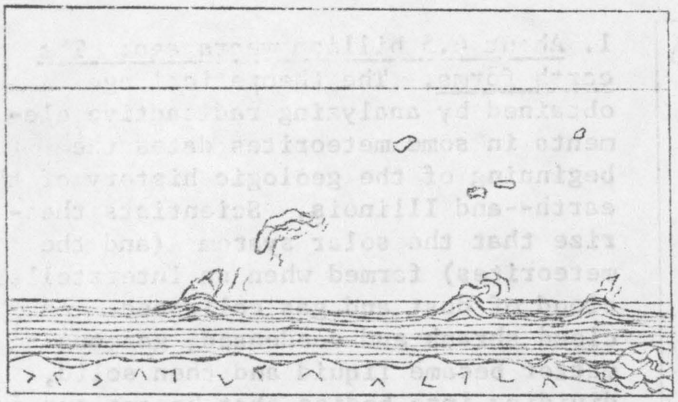
1. About 4.5 billion years ago: The earth forms. The theoretical age obtained by analyzing radioactive elements in some meteorites dates the beginning of the geologic history of the earth--and Illinois. Scientists theorize that the solar system (and the meteorites) formed when an interstellar cloud of dust and gas collapsed. As the cloud shrank and condensed, gaseous matter became liquid and then solid, dividing into bodies that became our sun and its satellites. On the earth, no rocks as old as the meteorites have been found.



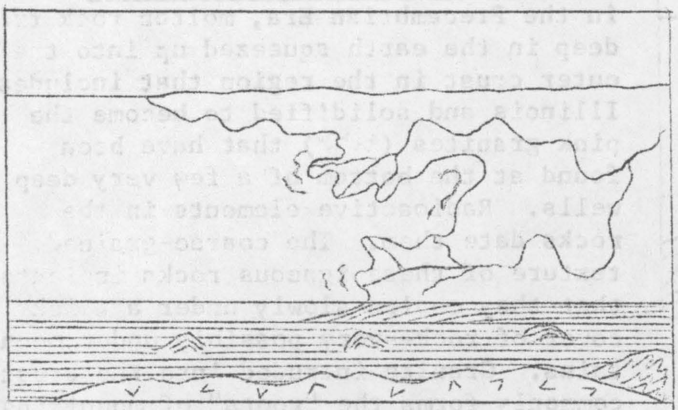
2. About 1.5 to 1.2 billion years ago: The oldest rocks in Illinois form. Late in the Precambrian Era, molten rock from deep in the earth squeezed up into the outer crust in the region that includes Illinois and solidified to become the pink granites (⌃⌃⌄) that have been found at the bottom of a few very deep wells. Radioactive elements in the rocks date them. The coarse-grained texture of these igneous rocks indicates that they cooled slowly under a thick cover of rock--very possibly under mountains. Granite intruded into the crust commonly forms the "roots" of mountains.



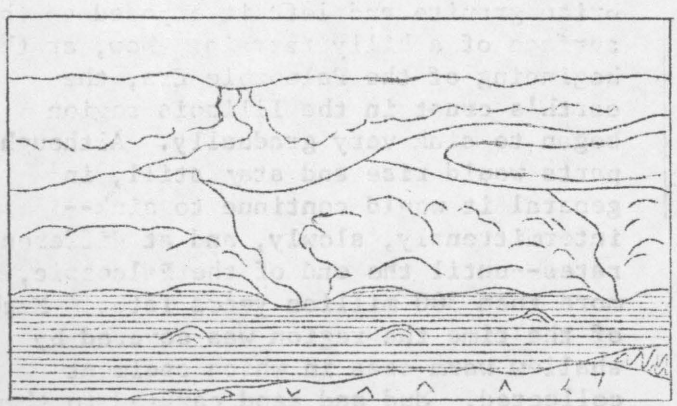
3. About 600 million years ago: The Illinois region begins to collect sediment. By this time, possibly 600 million to 900 million years of erosion had removed the rocks covering the Precambrian granite and left it exposed at the surface of a hilly terrain. Now, at the beginning of the Paleozoic Era, the earth's crust in the Illinois region began to sink very gradually. Although parts would rise and stay still, in general it would continue to sink--intermittently, slowly, and at different rates--until the end of the Paleozoic, more than 300 million years later. Much of the time the region was covered by shallow warm seas in which sediment collected. Mud and sand carried to them by rivers off the land became layers of shale and sandstone. Broken shell sediments and chalky muds that formed in the seas became limestone and dolomite beds.



4. About 400 million years ago: Reefs grew in a Silurian sea. About midway through the Paleozoic Era a shallow, warm sea covered the region. In it, generations of sea plants and animals, interlacing and cementing their skeletons and crusts together as they grew, built low platforms and mounds called "reefs." During this time and throughout the Paleozoic, different parts of the region were slowly warped up and eroded and then covered again by the sea. As a result, the Paleozoic rocks do not represent a continuous accumulation of sediment. As a record of geologic history, the rock layers in the region are like a book from which most of the pages have been randomly torn.

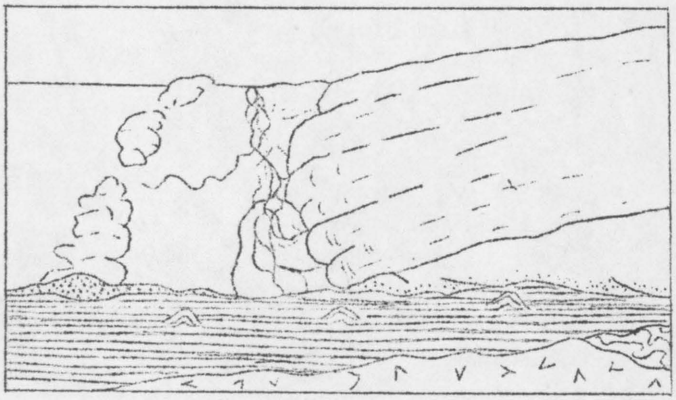


5. About 300 million years ago: Swamps and shallow seas alternately cover the region. In the latter part of the Paleozoic Era (late Mississippian and Pennsylvanian Periods) the Illinois region was still sinking, but in such a way that large parts of it were alternately covered by very shallow seas and swampy river deltas and floodplains lying just above sea level. Typically a cycle of deposition produced a set of marine limestone and mudstone layers and then buried it with a set of river-laid sandstones and mudstones. In the Pennsylvanian Period, peat beds accumulated in the dense swamp forests growing on the floodplains and were buried. These became Illinois' rich coal seams.



6. Between about 280 million years ago and 1 million years ago: The region is deeply eroded. Geologists who advocate the plate tectonics theory believe that early in this time interval a large block of the earth's continental crust began to pull apart--its fragments ultimately forming the present continents of North and South America, Africa, Europe, and Antarctica. Since sometime after the Pennsylvanian Period (near the end of the Paleozoic Era), most of the Illinois region remained above sea level. A thickness of as much as 5000 feet of rock may have been eroded away during this long interval, which includes the

Permian, Triassic, Jurassic, Cretaceous, and Tertiary Periods. Small gravel deposits in western Illinois and a belt of Cretaceous and Tertiary sands, clays, and gravels across the tip of southern Illinois are the only sediments representing this time in Illinois.



7. <u>Between about 1 million years ago and the present: The region is glaciated during the Pleistocene Epoch</u>. At least four times during the Pleistocene, the world climate cooled and ice sheets grew that covered Canada and northern parts of Europe. Glaciers from the Canadian ice sheets flowed into Illinois through the basins that now hold the Great Lakes. Ice, meltwater, and wind left deposits of loose sediment--silt, sand and gravel, sandy clay--over about 90% of the state. These deposits provide fertile, deep soils and abundant construction materials and water. The last glaciation ended about 7000 years ago and the time since, called the Holocene Stage, may be a warmer interval between glaciations.

ST. ANNE-MOMENCE GEOLOGICAL SCIENCE FIELD TRIP

INTRODUCTION

A picture of the area - Figure 1 is a diagram of the thicker deposits of earth and rock that can be seen at the surface of the field trip area. The diagram is called a geologic section. It shows an edge, or side view of the deposits as if one were seeing them in the side of a very deep, long ditch dug between St. Anne, Momence, and Grant Park.

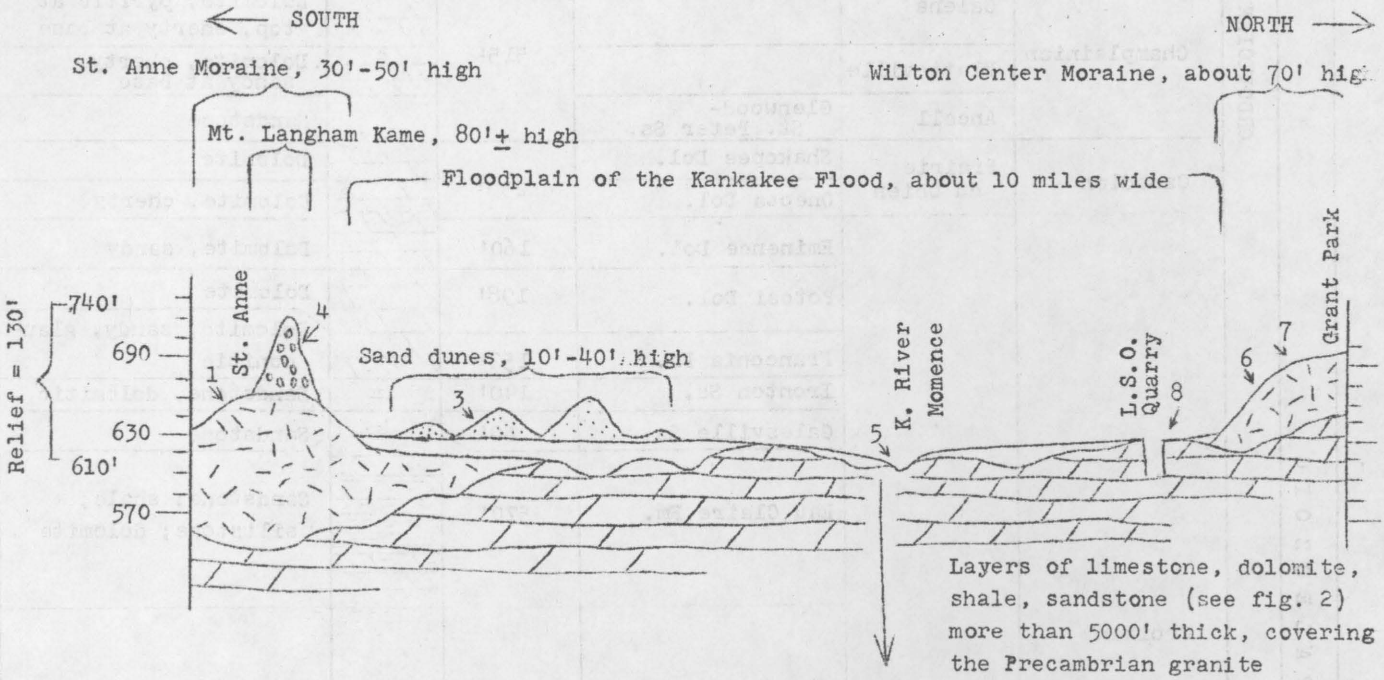
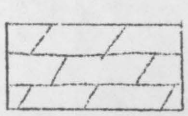


Fig. 1 - Geologic features in the field trip area. Numbers refer to field trip stops.

What the section shows - The surface of the field trip area (see the route map also) is essentially a floodplain bounded on the north and south (at Grant Park and St. Anne) by low ridges formed by continental glaciers. Thin layers of loose sediment--sands, clays, gravels, muds--deposited in the past million years by winds, streams, and glaciers cover layers of solid rock that are more than 395 million years old. These are the units shown in the section:



Dolomite - In this area the solid rock (bedrock) under the surface layers of loose earth consists of thick beds of dolomite. The top of the bedrock lies below the surface at depths ranging from a few feet to as much as 150 feet in this area. The dolomite layers formed from layers of shells, shell sand, and chalky muds that accumulated on the bottom of a warm sea in the Silurian Period, the interval of geologic time between 435 million and 395 million years ago. The dolomite quarried at Stop 8 is the Racine Dolomite (see figure 2).

Dolomite and the closely related rock, limestone, are important mineral commodities in Illinois. From them are produced crushed and broken stone for road surfacing and construction materials, industrial and chemical uses, and fertilizer. In 1974, Illinois produced 63,274,000 tons of limestone and dolomite valued at $116,041,000. The quarry visited at Stop 8 is a good example of the operations that produce broken and crushed stone in Illinois.

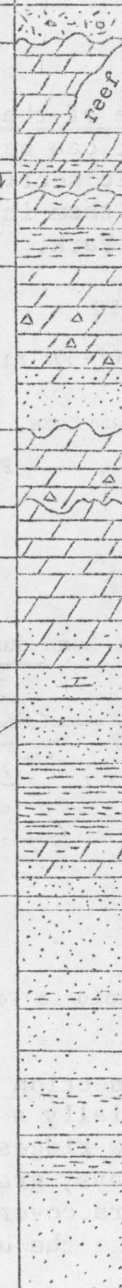
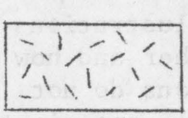
ERA	SYSTEM	SERIES	GROUP	FORMATION	APPROX. THICKNESS	GRAPHIC COLUMN	DESCRIPTION
CEN.	QUAT.	Pleistocene			0-100'		Till; outwash sand and gravel; lacustrine silt
PALEOZOIC	SILURIAN	Niagaran		Racine Dol. Sugar Run Dol. Joliet Dol.	350'		Dolomite; reefs
	SILURIAN	Alexandrian		Kankakee Dol. Elwood Dol. Wilhelmi Fm.	90' *		Dolomite, silty; some shale
	ORDOVICIAN	Cincinnatian	Maquoketa	Brainard-Ft. Atkinson Fms.	205'		Dolomite, silty
				Scales Sh.			Shale, dolomitic
		Champlainian	Galena		515'		Dolomite, pyritic at top, cherty at base
			Platteville				Dolomite, cherty; sandy at base
			Ancell	Glenwood-St. Peter Ss.			Sandstone
		Canadian	Prairie du Chien	Shakopee Dol.	230'		Dolomite
				Oneota Dol.			Dolomite, cherty
	CAMBRIAN	Croixan		Eminence Dol.	160'		Dolomite, sandy
				Potosi Dol.	198'		Dolomite
				Franconia Fm.	152'		Dolomite, sandy, glauconitic
				Ironton Ss.	140'		Sandstone, dolomitic
				Galesville Ss.	60'		Sandstone
				Eau Claire Fm.	570'		Sandstone; shale; siltstone; dolomite
				Mt. Simon Ss.	2270'	*	Sandstone, silty; arkosic (feldspar-rich) at base; some fine pebbles (Scale of graphic column: 1" = approximately 600')
PRECAMBRIAN							Granite

Fig. 2 - Generalized geologic column for St. Anne-Momence area. Interval between asterisks summarizes a sample study of a Hughes Oil Company well (ISGS County No. 400, No. 1, NW cor. NW¼SW¼ Sec. 24, T. 31 N., R. 13 E.) at Momence, Kankakee County.

Ground water, which fills the cracks and crevices in the dolomite, provides the principal source of water in wells in the area.

The dolomites are the upper layers of a series of dolomite, shale, and sandstone beds deposited on top of Precambrian granite during the early part of the Paleozoic Era. Figure 2, the geologic column, illustrates this series. The total thickness of these sedimentary rock units is a little more than 5000 feet at Momence --about 1/4000 of the earth's radius, 3,960 miles more or less.

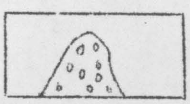
Silurian-Pleistocene unconformity - The irregular line drawn across the top of the dolomite beds symbolizes the irregular surface left on top of the bedrock by erosion. The unconformity is the surface of contact between glacial sediments some thousands of years old and dolomite several hundred million years old. In this area perhaps 200 million years of erosion since the end of the Paleozoic Era have worn away a great thickness of rock. Unconformities occur between many layers of sediment and rock where erosion interrupted deposition, but no other unconformity exposed in the area represents such a long time of erosion.



Glacial till - Layers of sandy, silty clay deposited by glaciers are exposed at the surface of the low hills at St. Anne and north of Momence. Glaciers--the flowing edges of continental ice sheets growing in Canada--advanced southward across this region through the basins that now hold Lake Michigan and Lake Erie. The tills at the surface here were deposited during the last glaciation--the Wisconsinan--in the time between about 16,000 and 13,000 years ago. Along buried bedrock valleys in the vicinity of St. Anne the glacial deposits are more than 100 feet thick. A thickness of 50 feet is average, however, and in much of the area between St. Anne and Momence, the Kankakee Flood washed them away entirely.

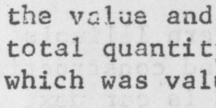
Deposits left by glacial ice and meltwater--glacial drift--cover about 90% of Illinois and form an extremely important resource. Glacial drift supports our constructions; supplies much of our water, sand and gravel, and brick clays; and is the parent material for much of our soil. It is the container for most of our solid waste and much of our fluid waste. The level terrain that the glaciers created has made our farms efficient and fertile.

In the field trip area, glacial till is used to make brick and tile. In 1972, Kankakee County produced 47,516 tons of face brick and tile. (A total of 1,996,000 tons of clay products, valued at $3,735,000, were produced in Illinois in 1974.)



Ice-contact drift - Mt. Langham, a conspicuous hill about 3 miles northwest of St. Anne, is a mound of sand and gravel that was deposited about 16,000 years ago when the glacier that built the St. Anne Moraine melted. Meltwater, which ran off the surface of the glacier and carried sediment washed from the ice, fell off the ice and heaped up sand and gravel.

Kankakee County has a number of sand and gravel pits in operation, but the value and amount of sand and gravel produced here has not been released. The total quantity of sand and gravel produced in Illinois in 1974 was 37,102,000 tons, which was valued at $59,734,000.



Kankakee Flood deposits - Between about 13,000 and 14,000 years ago, waters draining from rapidly melting glaciers to the north and east of the field trip area flowed west through the lowland between the moraines at St. Anne and Grant Park. The drainage, called the Kankakee

Flood, largely washed away the till sheet that covered the area and created the present Kankakee Valley. Where the Kankakee Flood ran swiftly, it deposited gravel and rubble bars. However, in much of the area it more closely resembled a lake than a river and deposited thin layers of sand, silt, and clay.

The sandy soils developed on the Kankakee Flood deposits are well-suited to bulb and truck crops, which are raised around Wichert.

Sand dunes - After the Kankakee Flood abated, and the Kankakee Valley drained, winds blew the sands deposited across the valley into dunes. The sand dunes are beautiful natural features, in general too dry and susceptible to wind erosion to cultivate. The sands are a mixture of minerals produced by the disintegration of rocks during the glaciations; they contain enough feldspar to supply it for some industrial uses.

Exaggeration in the drawing - Geologic sections are good illustrations to show how layers of rock and loose sediment lie in relation to each other and how their thicknesses compare with each other's. However, geologic sections do not usually show the natural proportions of features. Looking at Figure 1, one might conclude that the St. Anne-Momence area contained steep hills when, in fact, it is a level plain interrupted by low mounds and ridges and shallow valleys. The vertical scale of the features is greatly exaggerated.

To understand the problem of "vertical exaggeration" in the geologic section, consider that the distance between St. Anne and Grant Park is about 16 miles (or 84,480 feet). Since the drawing is 6 inches wide, one inch on the page equals about 14,000 feet on the ground. If the vertical scale of the drawing were the same as the "1 inch = 14,000 feet" horizontal scale, a feature 100 feet high would be 1/140 inch high. Figure 1 drawn with such a vertical scale would be no thicker than a line drawn across the page. Therefore, the vertical scale is "exaggerated," so that 1 inch = 150 feet and deposits less than 10 feet thick can be shown.

ITINERARY

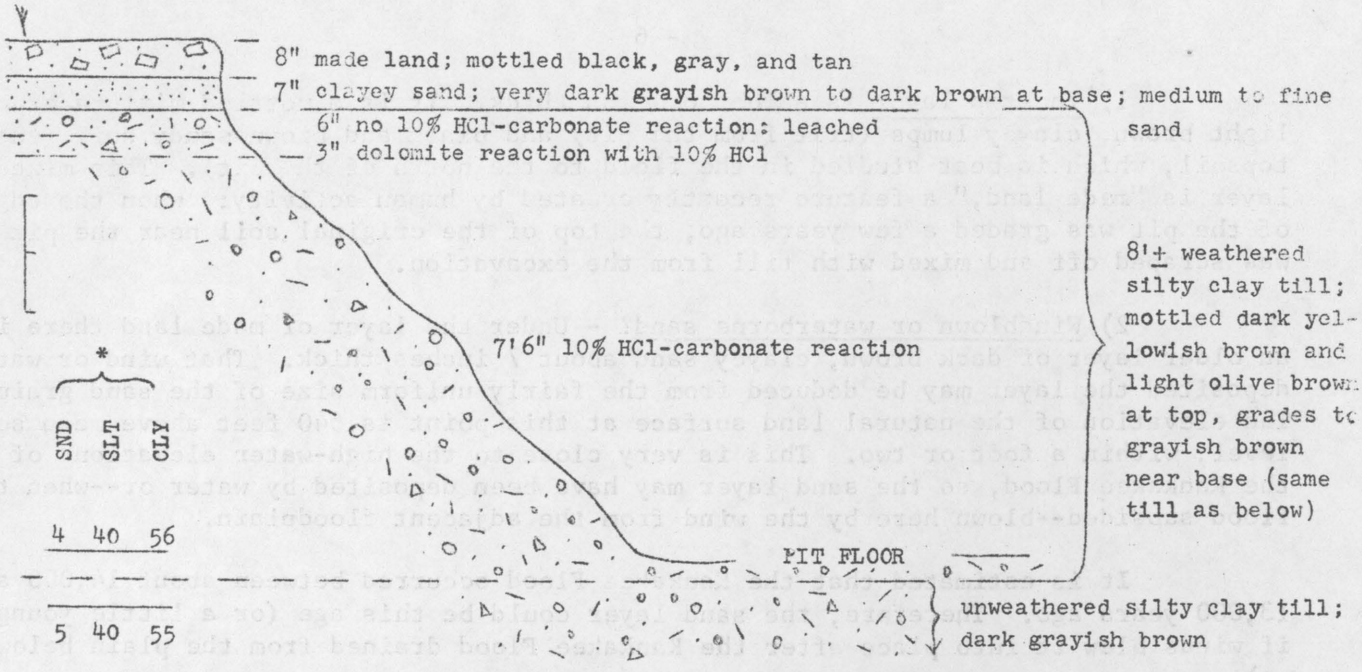
0.0 0.0 Line up in front of St. Anne Community High School, heading west on Guertin Street.

0.0 0.0 STOP - 2-way. South Dixie Highway. TURN LEFT (south).

0.15 0.15 Leave St. Anne.

0.1 0.25 Stop 1. An exposure of Wisconsinan till in Eastern Illinois Clay Company pit east of road. (NW¼SW¼NE¼ Sec. 9, T. 29 N., R. 12 W., Kankakee County, Momence 15-minute quadrangle.)

The clay pit and St. Anne Moraine - From this pit the Eastern Illinois Clay Company takes glacial till--a stony, silty clay--to make tile and construction blocks. (The plant is visible less than half a mile to the east and is our next stop.) Stop 1 is at the southern edge of the St. Anne Moraine, the low ridge to the north and northwest upon which St. Anne is built. A glacier built the St. Anne Moraine about 16,000 years ago with accumulations of till.



* % of sand, silt, and clay in the less-than-2mm fraction of the sample, determined by sieve and pipette analysis

Fig. 3 - Exposure of till in pit of Eastern Illinois Clay Company.

Some Things You Can Do Here 1. Collect a variety of igneous and metamorphic rocks. The glaciers brought them here from states to the North and Canada. 2. Find a rock that has been striated (scratched) and faceted (flattened) by the glacier. 3. Dig a hole in the pit floor and collect a specimen of fresh till. 4. Examine pieces of the gray New Albany Shale (the flat rock fragments that split into thin plates) and find fossil spores of Devonian age (395 million to 345 million years ago). Barely visible reddish brown specks to the unaided eye, the spores are seen as amber discs with a 10X handlens. 5. Scrape a track down the side of the pit to make a fresh, clean soil exposure, and examine the different materials, textures, and weathering zones in the soil profile (see text below).

Evidence of three geologic events in the soil profile - Three different layers of earth materials are exposed in the pit wall. (The section illustrated by figure 3 is in the north wall, about 100 yards east of the road.)

1) <u>The top layer</u> is a foot or less thick. It is a mottled mixture of light brown, clayey lumps (till from the pit) and black and brown sandy soil (the topsoil, which is best studied in the field to the north of the pit). This mixed layer is "made land," a feature recently created by human activity: when the edge of the pit was graded a few years ago, the top of the original soil near the pit was scraped off and mixed with till from the excavation.

2) <u>Windblown or waterborne sand?</u> - Under the layer of made land there is an older layer of dark brown, clayey sand about 7 inches thick. That wind or water deposited the layer may be deduced from the fairly uniform size of the sand grains. The elevation of the natural land surface at this point is 640 feet above mean sea level, within a foot or two. This is very close to the high-water elevation of the Kankakee Flood, so the sand layer may have been deposited by water or--when the flood subsided--blown here by the wind from the adjacent floodplain.

It is estimated that the Kankakee Flood occurred between about 14,000 and 13,000 years ago. Therefore, the sand layer could be this age (or a little younger if winds blew it into place after the Kankakee Flood drained from the plain below us).

3) <u>The oldest layer--glacial till</u> - Under the sand layer about 8 feet of till is exposed. The whole till deposit is much thicker than that, however. Records of nearby water wells drilled into bedrock indicate that thicknesses of till varying from less than 50 feet to more than 100 feet were deposited here and in the St. Anne Moraine.

A glacier deposits till in several ways. As it moves, it may smear down layers of the rock debris that it picks up and carries in its bottom ice. Till is also deposited when a glacier melts away, and the rock debris in its bottom ice is left in place. A glacier builds a moraine when it is flowing and when the amount of ice flowing forward to the front of the glacier is about equal to the amount of ice melting away at the front. Under these conditions, the till released from the melting ice is "stacked" in a narrow belt along the ice front and a ridge is built up.

Till is usually easy to identify. A poorly sorted material, till is an even mixture of many different sizes of rocks. Typically it is a compact mixture of sand, silt, and clay with boulders, cobbles, and pebbles scattered through it. Till deposits contain some pebbles and cobbles that have had very flat surfaces (facets) and long, straight scratches (striations) ground on them. Facets and striations are ground on these rocks when the glacier skids them over the bedrock surface.

<u>The soil profile</u> - As soon as rock or sediment is exposed at the earth's surface, air and water and living things begin to penetrate it and change it physically and chemically. The process of change is called "weathering." The weathering of the rock and sediment that form the land surface creates soil. The soil profile in the pit is about 9 feet thick--the vertical distance between the land surface and the unweathered grayish brown till below the pit floor (see fig. 3).

Because weathering begins at the exposed surfaces and progresses downward, the changes that it produces occur in zones parallel to the land surface. This can be demonstrated by examining the soil profile here in two or three places not far apart.

1) Dolomite and calcite leaching in the profile - A solution of 10% hydrochloric acid dripped down the face will not react with the sand layer and about the upper 6 inches of the till layer, demonstrating that calcite and dolomite have been leached out of these zones by descending water (refer to figure 3). The subdued and belated acid reaction in the 3-inch zone indicates that dolomite is present although the more soluble calcite has been leached out. Below this zone, the acid produces a vigorous, immediate reaction, indicating that the calcite and dolomite from the limestones and dolomite ground and mixed in the till by the glacier are only slightly affected by weathering.

2) Color changes in the profile - Coloring changes caused by weathering are conspicuous because oxidation changes gray iron minerals in the sediments to conspicuous yellow, brown, and red hues. Compare the color of the dark grayish brown unweathered till with the colors of zones higher in the till in the pit wall. Black, decaying plant materials darken the top zone of some soils--a sample from the field will illustrate this. Weathering in other soils may lighten the color of the upper zones by leaching out the coloring materials.

3) Changes in soil texture in the profile - Scraping a track down the profile to clean it off for examination, one can see that the soil tends to break naturally into blocks and crumbs of different sizes and shapes. These natural soil blocks and crumbs, called peds, form as a consequence of weathering. Different kinds of material and different zones in a soil form different kinds of peds. The sand layer, for example, does not have obvious ped structures. The till layer, however, has evident angular, blocky peds that increase in size downward.

4) The age of the soil profile - This is an immature soil profile: it is only about 9 feet thick and does not have the highly distinct zones of soil color and texture that older soils have. The profile began to form after the glacier that deposited it melted away, so the profile in the till is about 16,000 years old. The made-land layer at the top of the profile is new, but weathering has already begun to obliterate its original texture.

0.0	0.25	Leave Stop 1. TURN AROUND and retrace itinerary (north).
0.1	0.35	CAUTION - enter St. Anne.
0.15	0.5	STOP - 2-way. Guertin Street. TURN RIGHT (east).
0.5	1.0	TURN RIGHT (south) on South Chicago Avenue.
0.1	1.1	Stop 2. Office of Eastern Illinois Clay Company. (SE¼NE¼NE¼NE¼ Sec. 9, T. 29 N., R. 12 W., Kankakee County, Momence 15-minute quadrangle.)

BE CAREFUL OF MACHINERY AND MOVING EQUIPMENT

The Eastern Illinois Clay Company established this plant in 1916. Management has continually strived for better production methods, and new equipment has been installed to automate and increase production. Up until 1960 the kilns were coal fired from a number of grated fire boxes around the perimeter near the base of each kiln. The kilns were then converted to oil and gas firing and finally to natural gas entirely. By using cleaner fuel the company was able to clean up its firing prodedures. Notice that there are no odors or fumes associated with the firing of the kilns, nor is there any smoke coming from the stacks.

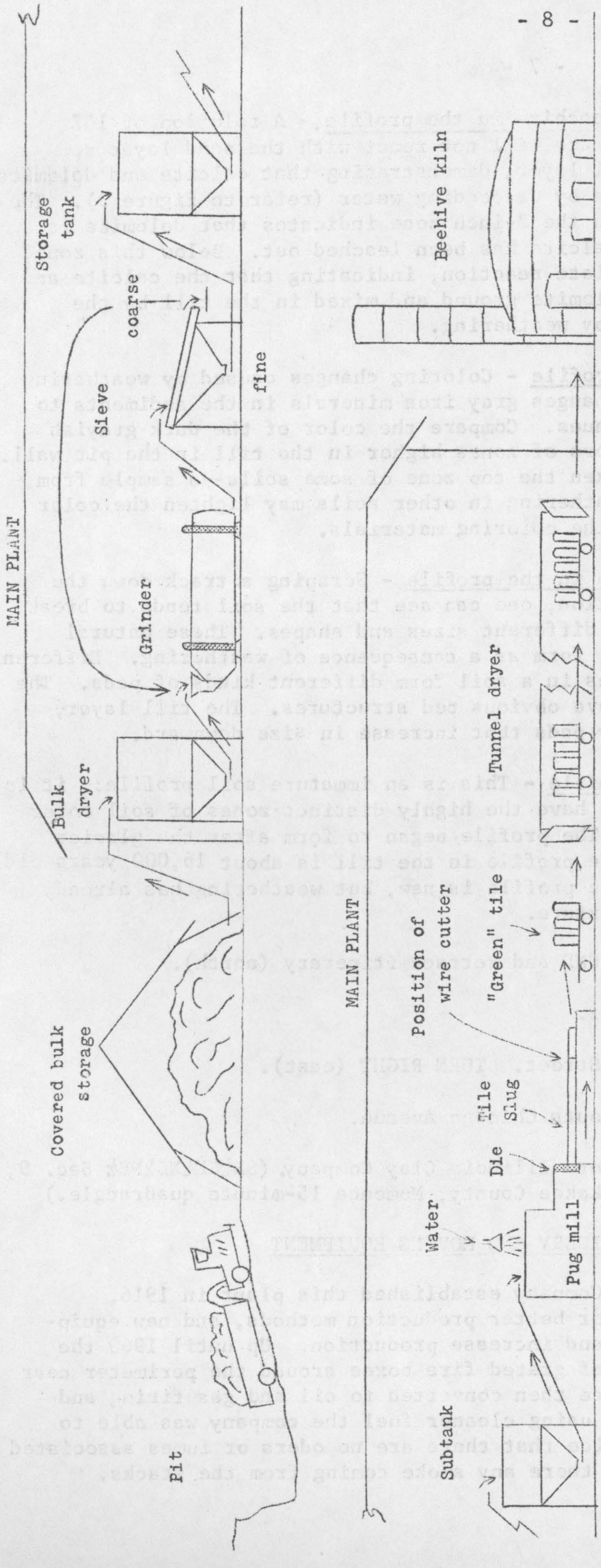


Fig. 4 - Flow sheet illustrating steps in the manufacture of clay products at Eastern Illinois Clay Company, St. Anne.

Figure 4 is a schematic diagram of the clay products manufacture at Eastern Illinois Clay Company. As noted earlier at Stop 1, weathered glacial till is mined and brought to storage sheds, that although roofed, have no closed sides. Weathered till is used because the carbonate (calcite, limestone, and dolomite) fragments have been leached out. Carbonates burn and expand during firing and would cause a larger number of rejects in the finished product.

There is an adequate supply of the till stored to carry the operations through wet weather periods and the winter. From bulk storage the till is conveyed into the main building, where drying is completed and it is mixed with shale brought in from western Indiana, about 55 miles to the south-southeast. After blending, the raw materials are fed into grinders for granulation and then sieved through vibrating screens having 14 openings per linear inch. The coarse fraction of the mix is shaken off the top of the slanted screen and carried by conveyor belt back to the grinder.

The fine fraction from the screening operation goes into bulk storage tanks. Vibrator feeders at the bottom of these tanks load the material onto conveyor belts that take it to a subtank. The speed of the feeders and belts and, thus, the amount of material carried are controlled by an electric eye that monitors the level of mixture in the subtank. From the subtank, the material is conveyed over automatic weighing rollers before it is fed into the pug mill, a horizontal mixing trough. The weighing rollers control the amount of water to be added to the material in the pug mill. Just the right amount of water must be metered to the raw material to make it plastic enough to be molded yet strong enough to hold its shape. Rotating arms or bars inside the pug mill thoroughly blend the raw material and the water to form the uniform plastic mixture that can be carried and compressed by an auger, or large screw, in the bottom of the pug mill. The compacted plastic mixture is forced (extruded) through an orifice, or die. Dies of different sizes and shapes can be installed on the end of the machine in order to produce brick, construction tile, or field tile.

The extruded slug is cut (sliced) into proper lengths by wires attached to a rotating cutter machine. Men load the "green" (uncured) clay products onto wheeled steel transfer cars on small iron tracks. When a car has been loaded, it is rolled into a closed tunnel, where hot air vented from the beehive kilns dries and cures the product. After curing, the clay products are transferred on the cars to an empty kiln (oven), where they are unloaded and stacked. Space must be left around the kiln sides and top and between each stacked item so that heated air can easily circulate through the kiln and thoroughly bake the products. The opening (door) to the kiln is then sealed shut with special bricks, the gas burners around the sides of the kiln are ignited, and the inside temperature slowly raised to about 1800°F. After baking for several hours at this elevated temperature, the kiln and its contents are allowed to slowly cool before the door is broken open and the finished clay products are removed for shipment. The firing cycle from the time the door is sealed shut until it is broken open varies from about 100 hours for a 32-foot diameter kiln to approximately 120 hours for a 40-foot kiln.

Finished clay products from this plant are sold only to wholesale distributors, mostly in the Chicago area.

0.0	1.1	Leave Stop 2. TURN AROUND and retrace itinerary (north).
0.1	1.2	STOP - 2-way. Guertin Street. TURN RIGHT (east). USE EXTREME CAUTION on turning because of Chicago and Eastern Illinois Railroad (C & EI) crossing - 3 tracks.
0.2	1.4	CAUTION - Penn Central Railroad (PC) crossing.
0.05	1.45	Leave St. Anne. CONTINUE AHEAD (east).
0.3	1.75	Note flatness of this area, which is the bottom of glacial Lake Wauponsee. The tree line extending northwestward from east to north roughly outlines the southern edge of a sand dune field that the trip will visit. The soil is quite sandy here but becomes progressively more sandy eastward.
1.0	2.75	The low hills traversed along this part of the itinerary are formed from sandy Kankakee Flood deposits.
3.4	6.15	Note extreme sandiness of driveways and roadcuts along this portion of itinerary.
0.55	6.7	CAUTION - Chicago Milwaukee St. Paul and Pacific Railroad (CMStP & P) crossing.
0.4	7.1	Roadcut through this dune is unstable. Erosion has exposed the telephone cable along the north side of road.

0.75 7.85 Stop 3. Roadcut through large sand dune. (Near center of N edge NE¼ Sec. 10, T. 29 N., R. 11 W., Kankakee County, Momence 15-minute quadrangle.)

CAUTION - road shoulders are soft, even when dry. DO NOT pull too far off of road.

This large sand dune is part of a dune field that covers about 50 square miles in the southeast corner of Kankakee County. The field extends a long distance east into Indiana. As the route map shows, the low dune ridges and knolls are arranged in lines that roughly form nested V's pointing west. Most of the dunes are 15 to 25 feet high, although some reach 50 feet. The dune at this stop is about 45 feet thick: the exposure in the roadcut is nearly 25 feet high and 20 feet have been measured below the road level in an auger hole.

The forested dunes are interesting and beautiful natural features, but somewhat fragile. Composed of incoherent sand and with a tendency to dry out quickly at their surface, the dunes are susceptible to wind erosion if sizable holes are made in the plant cover that breaks the wind and stabilizes the sand. Several "blowouts"--hollows eroded in the sides of dunes by the wind--will be seen farther along the route. Even careless foot traffic can scuff through the lichen and small plant carpet and impress tracks that last for years in the loose soil.

Things You Can Do Here

1. Pick up a pinch of sand and examine the shapes, sizes, and colors of grains with your eye and handlens.

2. Find evidence of wind erosion and damage to ground cover.

3. Compare the vegetation and soil in the bare sand, "weedy" sand, and plant-covered areas.

4. Look at the traces that wind and animals leave in loose sand.

5. Take a sample of sand to make a micro-mineral collection. (To sort and mount grains one at a time, examine the sand under a 10X lens and pick up a grain with the wet tip of a small water color brush. Mount the wet grain by touching it to a spot of dried white glue painted on a white card.)

How the dunes formed - The Kankakee Flood carried an immense quantity of sediment. At its highest level (about 640' MSL), it covered most of the field trip area and deposited a blanket of silt and sand over it. Locally, the only land areas above water during the highest water level were the St. Anne Moraine and the Wilton Center Moraine north of Momence.

When the Kankakee Flood drained away about 13,000 years ago and the floodplain dried, winds blew the loose sands into dunes. As soon as plants covered the dunes, they stopped drifting, and most of them have been in their present positions a long time.

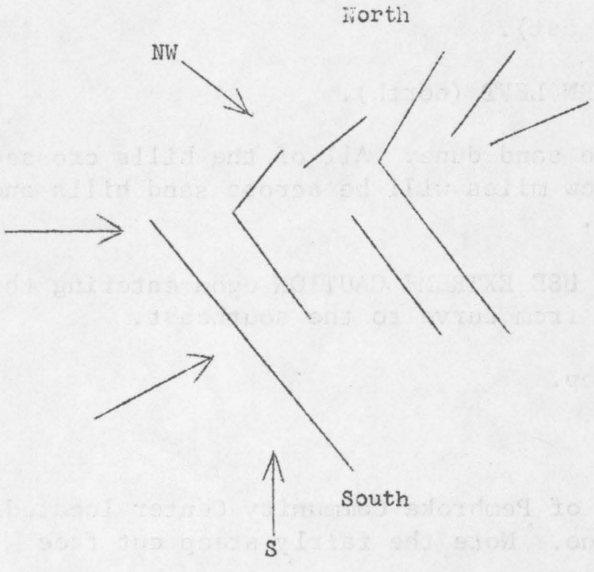


Fig. 5 - Alignments of dune ridge crests ( ) and prevailing wind directions ( ) in the dune field.

Many of the dunes are arranged in lines that form nested V's pointing west. A number of the shorter, more weakly developed limbs of the V's are aligned northeast-southwest (between 30° and 60° east of north). The longer, more strongly developed southern limbs are aligned northwest-southeast, mainly at about 40° west of north. (See figure 5.) These dunes, like snow drifts and other sand dunes, formed at right angles to prevailing winds, with their gentler slopes facing the wind (to the west) and their steeper slopes downwind (to the east). The winds that formed these dunes and the dune field evidently blew from the northwest and the southwest.

According to Dr. Nani Bhowmik of the Illinois State Water Survey, the strong prevailing winds in this region blow during the January-July season from the northwest, west, southwest, and southern quarters. If one assumes that the dunes in this field formed about 13,000 years ago, the V-shaped alignments of the dunes seem to demonstrate that the strong winds then prevailing in this region blew from the same quarters as winds do now.

Evidence of the time of dune formation - During a recent study of the dune field, a Survey geologist, J. M. Masters, augered a hole 20 feet deep from the bottom of the roadcut down through the base of the dune. At the bottom of the hole, the auger penetrated peaty sand. From this layer of partly rotted plant debris and sand, he collected a sample of plant fragments which was later dated by carbon-14 analysis. The radiocarbon age of the sample (Illinois State Geological Survey No. 271) was 12,990±120 radiocarbon years B.P. (Before Present). Presumably, this is the time when dune sand drifted over the marsh area and buried the plants and the plant debris that had accumulated.

The dunes as a source of feldspar - Examining the sand with a handlens, one observes that the grains are of different colors and transparencies. The sand is made up of different minerals, most of them fragments of igneous and metamorphic rocks brought from Canada and our northern states by glaciers. Most of the sand grains are quartz, which is transparent and colorless. Transparent pink, red, or orange grains are usually garnet. A green grain may be either hornblende or epidote. Opaque, black grains are either ilmenite or magnetite--these minerals being magnetic, a magnet will separate them from a dry sample. Clear and light to dark brown flakes are mica. Feldspar grains are translucent pink or white to gray.

The feldspar minerals are the conspicuous blocky, red to pink or white to gray grains in granites and other igneous rocks. The mineral has a number of commercial uses, an important one in Illinois being as an ingredient in the manufacture of glass. At present, feldspar is imported from outside the state. However, research by the Industrial Minerals Section at the Survey has established that after preliminary treatment, the sand in this dune field contains from 11% to 22% feldspar and that further beneficiation produces a satisfactory concentrate for glass manufacture.

0.0	7.85	Leave Stop 3. CONTINUE AHEAD (east).
0.3	8.15	CAUTION - T-road from left. TURN LEFT (north).
1.85	10.0	Itinerary crosses top of a large sand dune. All of the hills crossed by the itinerary for the next few miles will be across sand hills and ridges. CONTINUE AHEAD (north).
0.7	10.7	STOP. CONTINUE AHEAD (north). USE EXTREME CAUTION upon entering the road because of poor visibility from curve to the southeast.
0.35	11.05	CURVE LEFT (west) on the blacktop.
1.05	12.1	CAUTION - enter Pembroke.
0.25	12.35	View to right (north-northwest) of Pembroke Community Center located on a terrace cut into a sand dune. Note the fairly steep cut face of the dune behind the center.
0.2	12.55	CAUTION- CMStP&P Railroad crossing. CONTINUE AHEAD (west).
0.55	13.1	STOP - Doney crossroad. CONTINUE AHEAD (west).
0.3	13.4	View to right (north) of road shows an area of bare sand about 0.1 mile away. The grass cover has been destroyed on this part of the dune, and the wind has easily moved the sand up over the top of the dune. This feature is called a blowout. Grass is slowly encroaching upon the lower portion of the blowout; thus, in time, the area may become stabilized again.
0.2	13.6	View to right (north) shows a couple of good examples of blowouts about 0.25 mile away.
0.8	14.4	Open burning of trash takes place in the clearing about 200 feet north of the road.
0.5	14.9	CAUTION - the next segment of the road is very rough and difficult to maintain.
0.1	15.0	Note indiscriminate dumping along the roadside.
0.8	15.8	Ascend dune. CAUTION - do not get off the roadway here because shoulders are soft and junk covered.
0.1	15.9	Crushed stone has been placed on the sand road here to give the road a better foundation.
0.55	16.45	USE EXTREME CAUTION - crossroads, no stops. The north-south road crossed by the itinerary is a blacktop and traffic moves fast. CONTINUE AHEAD (west) on gravel.
0.5	16.95	The itinerary enters an area of truck farming where pumpkins, squashes, onions, gladioli, etc. are grown, especially for the Chicago market.
0.1	17.05	CAUTION - C&EI Railroad crossing.

0.4	17.45	STOP - 2-way. TURN LEFT (south) on blacktop.
0.5	17.95	STOP. Wichert. CONTINUE AHEAD (south).
0.5	18.45	CAUTION - T-road intersection. TURN RIGHT (west) on gravel road.
1.0	19.45	STOP - intersection with Illinois Route 1. CAUTION - CONTINUE AHEAD (west) on gravel road.
0.05	19.5	The itinerary ascends the low-lying St. Anne Moraine which crosses the area from northwest to southeast. From this point to the crest of the moraine, less than 1.5 miles ahead, the vertical relief is less than 50 feet.
1.25	20.75	Wabash Pipeline Company crossing. This pipeline carries petroleum products into northwestern Indiana.
0.05	20.8	Crest of the St. Anne Moraine.
0.15	20.95	CAUTION - crossroad. CONTINUE AHEAD (west). The large, tree-covered hill to the upper right (northwest) is Mt. Langham.
0.25	21.2	Abandoned PC Railroad crossing.
1.2	22.4	CAUTION - crossroad. TURN RIGHT (north) on blacktop.
0.3	22.7	View to the upper left (northwest) shows the Kankakee skyline, between 4 and 5 miles away.
0.6	23.3	Abandoned PC Railroad crossing.
0.0	23.3	Stop 4. View of Mt. Langham and Kankakee Flood area and discussion of events pertaining to their formation. Do NOT park on tracks. (W edge NW¼NW¼NE¼ Sec. 25, T. 30 N., R. 13 W., Kankakee County, Kankakee 15-minute quadrangle.)

The kame - The high hill to the east is Mt. Langham which has a crest elevation of about 736 feet mean sea level, or nearly 85 feet above the old railroad crossing. Mt. Langham, which is one of the highest points in Kankakee County, has been interpreted as a "kame" (see Pleistocene appendix for its formation). Gravel has been removed from the excavations visible on the west side of the hill. It has been thought that perhaps the Lake Michigan and Lake Erie ice lobes were in contact here and a reentrant developed between the two lobes of ice in which the gravel was deposited.

Problems with moraines and tills - The main drainageways that had been cut through the moraines were not large enough to carry all of the meltwater from the Valparaiso glacier. Water levels of the Kankakee Flood rose and spilled over low sags in the moraines and erosion proceeded rapidly, so that when the water subsided, only irregular, discontinuous morainal crests were left. The patchy, discontinuous occurrence of a number of the moraines in this area has left considerable doubt as to their proper identity and the relationships between them.

The color and texture of the till of the St. Anne Moraine is comparable to those characteristic of till in the Marseilles moraines that lie about 6 miles west of this locality. These characteristics are also similar to those of the

Rockdale Moraine about 8 miles to the northwest, beyond Kankakee, and even to the Minooka Moraine which lies farther north and west. However, the clay mineral composition differs between the Marseilles and the others, and, more importantly, the carbonate composition is decidedly different. The Marseilles tills, as well as older Wisconsinan tills, are markedly low in carbonates, whereas the St. Anne, Rockdale, Minooka, and younger tills are relatively high in carbonates. Therefore, it appears that the St. Anne till is more closely allied to the Rockdale and Minooka tills than it is to the Marseilles. This correlation would dispell the thought of the two ice lobes meeting in this area because one would then expect to find large differences in composition, texture, clay mineral and carbonate makeup between the St. Anne till and tills to the north.

Glacial Lake Watseka - The view to the south and southwest from this vantage point is across the valley of the Iroquois River and the area occupied by glacial Lake Watseka. Meltwaters overflowing from Lake Wauponsee through here and through other erosional outlets in the St. Anne Moraine swept westward and southward to become ponded for a time between the St. Anne Moraine, the Marseilles Morainic System, the Chatsworth Moraine, and the Iroquois Moraine (see figure 6).

0.0	23.3	Leave Stop 4. CONTINUE AHEAD (north).
0.6	23.9	STOP - T-road intersection. TURN LEFT (west).
0.9	24.8	Abandoned PC Railroad crossing.
0.35	25.15	STOP - T-road intersection. TURN RIGHT (north) toward Aroma Park. Note sod farm to the left (west) just after making turn. At this point we have descended to the floodplain of the Kankakee Flood again.
0.25	25.4	Cross Kankakee River.
0.1	25.5	Enter Aroma Park. (The town's name is the result of a play on words, according to a September 3, 1975 story in the Kankakee Daily Journal. When the town was platted in 1852, the original name was "Aroma," a play on the name of James L. Romer. However, because of the similarity of the name and location to Aurora, much confusion prevailed, and the name was changed to Waldron after the Big Four Railroad magnate. Confusion continued, however, until 1915 when both the village and the railroad station agreed to the present name of Aroma Park.)
0.2	25.7	STOP - 4-way. TURN LEFT (west).
0.3	26.0	TURN RIGHT (north) on North Lowe Road.
0.35	26.35	Leave Aroma Park.
0.15	26.5	Abandoned PC Railroad crossing. CONTINUE AHEAD (north).
1.05	27.55	Excellent view ahead of the north valley wall of the Kankakee Flood.
0.35	27.9	View to right (east) of a large number of glacial boulders (erratics) on both sides of the drainage ditch.
0.35	28.25	Ascend north valley wall of Kankakee Flood.
0.1	28.35	Exposure of glacial till in the ditch on right side of road.

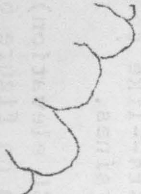
0.35	28.7	STOP - intersection with Illinois Route 17 (4-lane). USE EXTREME CAUTION - TURN RIGHT (east) on Route 17. During the inferred highest levels of the Kankakee Flood (elevations of 640-650 feet), this immediate vicinity was either barely covered by the Flood or was slightly emergent.
0.25	28.95	Excellent view ahead (east) and to the right (south) of the Kankakee Flood area from near the top of the north valley wall.
0.25	29.2	View to right (south) of Mt. Langham about 4 miles away on the south side of the valley.
0.85	30.05	Notice the flatness of the valley bottom in this vicinity, at one time the bottom of glacial Lake Wauponsee.
1.8	31.85	Cross Kankakee River.
1.45	33.3	CAUTION - intersection with Illinois Route 1. CONTINUE AHEAD (northeasterly) on Routes 1 and 17.
2.15	35.45	The low hills in this area are composed of dune sand that for the most part has been stabilized.
3.25	38.7	STOP - intersection with Illinois Route 14. TURN LEFT (north) on Routes 1 and 17 and cross Kankakee River to the island.
0.05	38.75	CAUTION - enter island.
0.05	38.8	TURN RIGHT (east) on Mill Street.
0.25	39.05	STOP - entrance to Momence Island Park. CONTINUE AHEAD WITH CAUTION to east end of park through low C & EI Railroad underpass.
0.0	39.05	Stop 5. Lunch. (NE¼SE¼NW¼NW¼ Sec. 19, T. 31 N., R. 14 E., Kankakee County, Momence 15-minute quadrangle.)

The History of the Kankakee Flood - The wide valley and floodplain in which the Kankakee River flows today were created between 13,000 and 14,000 years ago by an incomparably greater flow of water called the Kankakee Flood. The Kankakee Flood occurred when a glacier called the Lake Michigan Lobe was near the position shown in figure 6 and was building the Valparaiso Morainic System. Meltwater from this lobe and from the Saginaw and Erie Lobes advancing from the northeast drained into the lowland between the Lake Michigan Lobe and the moraines south of it and flowed westward.

Apparently the glaciers were melting very rapidly, for an extraordinary volume of water was released from them. As figure 6 shows, the flood drained toward Ottawa, Illinois. However, the existing outlet through the moraines along the Illinois Valley was not large enough to accommodate such a large flood and the waters spread widely over the upland areas between the moraines. As the flood rose, it also overflowed southward through gaps in moraine crests--like the one at Aroma Park--and created lakes in the lowlands between other moraines.

At the highest level of the water--about 650 feet (MSL elevation)--Lakes Pontiac, Ottawa, Watseka, and Wauponsee covered the areas shown on figure 6. At

Fig. 6 - Sources, flowlines, and extent of the Kankakee Flood.



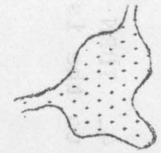
- General position of lobe edges during Valparaiso glaciation [1]

- Major flow lines of the Kankakee Flood [1, 3]

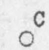
- Outwash, mainly sand and gravel, along the course of the Kankakee Flood [2]

- Trace showing the courses of some present-day rivers

- Wisconsinan end moraines older than the Valparaiso Morainic System [2]



- Lakes at the 650±-foot level of the Kankakee Flood: L. Ottawa (L.O.); L. Pontiac (L.P.); (L. Wauponsee (L.W.); L. Watseka (L.Wk.) [2]



- Locations of cities: South Bend (SB); Valparaiso (V); Lafayette (L); Kankakee (K); Chicago (C); Ottawa (O); Bloomington (B).

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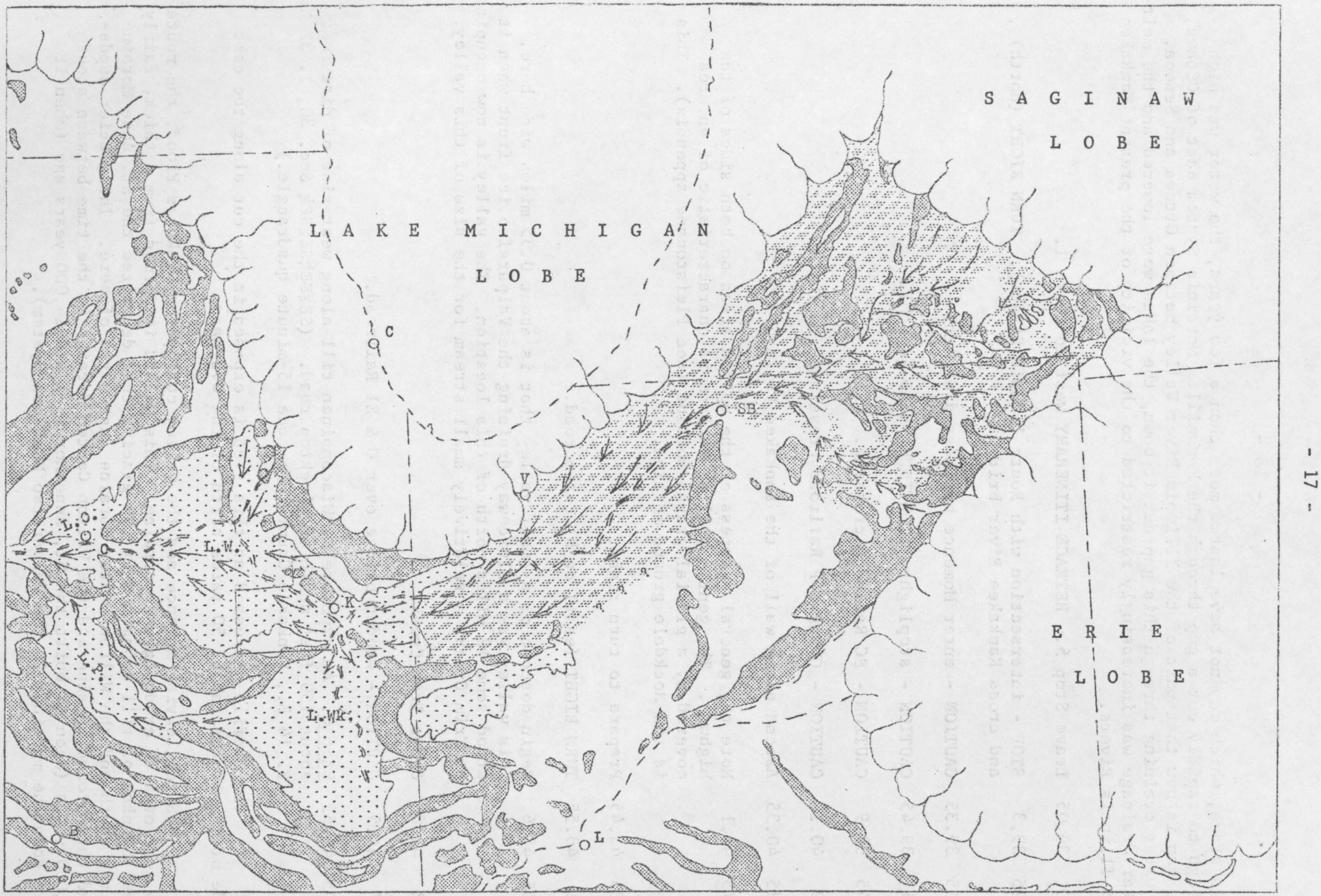
[2] R. F. Flint and others, 1959, Glacial map of the United States east of the Rocky Mountains: Geol. Soc. America.

[3] L. F. Athy, 1928, Geology and mineral resources of the Herscher Quadrangle: Illinois Geol. Survey Bull. 55, p. 92.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this stage, which may not have lasted more than a few years, the water was high enough to rapidly cut a gap through the Marseilles Morainic System east of Ottawa, The gap is now that part of the Illinois River Valley between Ottawa and Seneca. As water draining through this gap cut it down, the lakes were lowered and the meltwater drainage was increasingly restricted to the vicinity of the present Kankakee and Illinois Rivers.

0.0	39.05	Leave Stop 5. RETRACE ITINERARY west to Route 1.
0.25	39.3	STOP - intersection with Route 1 (Main Street). TURN RIGHT (north) and cross Kankakee River bridge.
0.05	39.35	CAUTION - enter Momence business district.
0.1	39.45	CAUTION - stoplight. CONTINUE AHEAD (north).
0.45	39.9	CAUTION - PC Railroad crossing.
0.2	40.1	CAUTION - CMStP & P Railroad crossing.
0.25	40.35	Ascend north wall of the Kankakee Valley.
1.75	42.1	Note the general evenness of the upland areas on both sides of the highway. The gently rolling surface is characteristic of an area covered by a glacial ground moraine (see Pleistocene appendix). This is the Rockdale ground moraine.
1.35	43.45	Prepare to turn right.
0.1	43.55	TURN RIGHT (east) on blacktop road.
0.05	43.6	Begin descent of a small valley that is about 0.35 miles wide here. This valley was a sluiceway draining the Valparaiso ice front when it stood some 12 miles north of this location. The valley is now occupied by Trim Creek, a relatively small stream for the size of this valley.
0.2	43.8	Cross Trim Creek.
0.7	44.5	CAUTION - wooden bridge over C & EI Railroad.
0.05	44.55	Stop 6. An exposure of Wisconsinan till along west side of dirt road about 150 feet north of blacktop road. (SE¼SE¼SE¼SE¼ Sec. 30, T. 32 N., R. 14 E., Kankakee County, Momence 15-minute quadrangle.)

The profile discussed at this stop is exposed in the cut along the east side of the tracks, about 50 yards north of the overpass.

Since leaving Momence and the valley cut by the Kankakee Flood, the route has gone over an eroded ground moraine. This upland is formed from a thick, fairly level blanket of till deposited by the glacier that deposited the St. Anne Moraine to the south and the Wilton Center Moraine just north of here. The glacier deposited this ground moraine and the Wilton Center Moraine in the time between about 16,000 years (when it built the St. Anne Moraine) and 14,000 years ago (when it laid down the moraines in the Valparaiso Morainic System).

The till exposed in this cut is very much like the till exposed in the clay pit at St. Anne (Stop 1) and is nearly as old, so a review of the points made in the discussion at Stop 1 will explain many of the features seen here. Unlike the profile at Stop 1, however, this profile does not contain a layer of sand. This upland was above the level of the Kankakee Flood.

Examining the outcrop - Figure 7 and the investigations suggested below can assist your study. You might use the outline in figure 7 to draw a geologic section somewhat like figure 3--use your own ideas, however. The vertical scale in figure 7 will help you represent accurately the vertical thicknesses of the layers and their vertical depth from the top surface of the exposure.

1. Find the human-deposited "junk zone" in the exposure. The plane of contact--the unconformity--between the Pleistocene till and Holocene made-land is at its base. Draw a horizontal, wavy line in the figure to show the unconformity. Label it. Make up a symbol to represent the junk zone in the figure.

2. Find the layer of made land. Notice that in the short time since it was put down, it has developed visible soil zones. The upper zone is darker and reacts more slowly with acid than the lower zone. Make up a symbol to represent the made land and draw the layer in the figure.

3. Scrape a clean surface down the profile and drip 10% hydrochloric acid

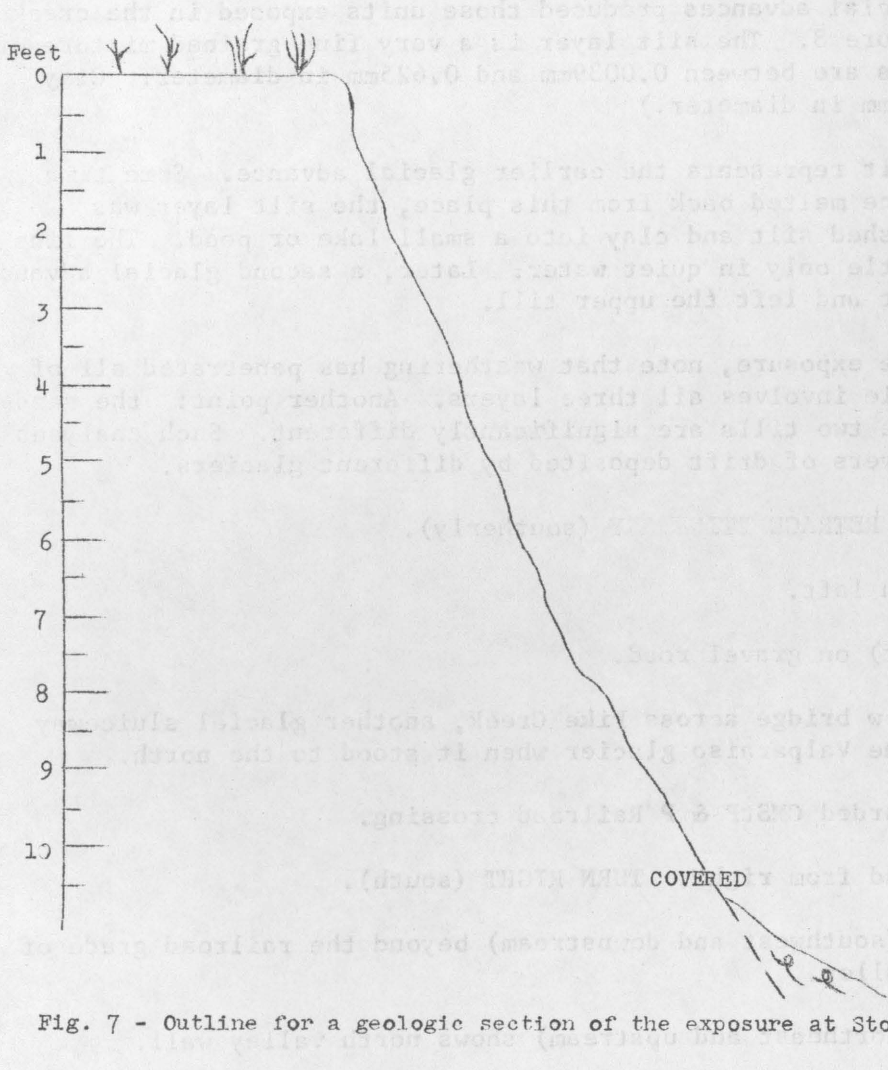


Fig. 7 - Outline for a geologic section of the exposure at Stop 6.

down it every few inches to find the zones that contain calcite and dolomite. On the geologic section, draw dashed horizontal lines to show the divisions between the leached zones and the reacting zones. Label the zones.

4. Fill in the diagram with the till symbol to show how much of the profile is till, which has not been moved since the glacier deposited it.

5. Separate the outcrop into different soil zones on the basis of soil color and texture (ped size and shape) and show these in figure 7. (If you are a high school student or teacher, the ag teacher might help you with your soil studies.)

0.0	44.55	Leave Stop 6. CONTINUE AHEAD (east).
0.65	45.2	STOP - T-road intersection. TURN LEFT (north).
0.75	45.95	Stop 7. Exposures of Wisconsinan till along small stream and in roadcut. (N½SE¼NE¼ Sec. 29 and NW¼SW¼NW¼ Sec. 28, T. 32 N., R. 14 E., Kankakee County, Momence 15-minute quadrangle.)

The exposure described here is south of the Highway 17 curve in the south bank of the channelized creek, about 50 yards east of the new concrete bridge.

Two different glacial advances produced those units exposed in the creek bank and illustrated by figure 8. The silt layer is a very fine grained mixture of silt and clay. (Silt grains are between 0.0039mm and 0.625mm in diameter. Clay grains are less than 0.0039mm in diameter.)

The lower till unit represents the earlier glacial advance. Some time after the ice of that advance melted back from this place, the silt layer was deposited by water which washed silt and clay into a small lake or pond. The fine silt and clay particles settle only in quiet water. Later, a second glacial advance flowed over the silt deposit and left the upper till.

As you examine the exposure, note that weathering has penetrated all of the layers: the soil profile involves all three layers. Another point: the sand-silt-clay percentages of the two tills are significantly different. Such analyses are used to identify the layers of drift deposited by different glaciers.

0.0	45.95	Leave Stop 7. RETRACE ITINERARY (southerly).
1.15	47.1	Prepare to turn left.
0.1	47.2	TURN LEFT (east) on gravel road.
0.9	48.1	CAUTION. Narrow bridge across Pike Creek, another glacial sluiceway that drained the Valparaiso glacier when it stood to the north.
0.5	48.6	CAUTION - unguarded CMStP & P Railroad crossing.
0.05	48.65	CAUTION - T-road from right. TURN RIGHT (south).
0.75	49.4	View to right (southwest and downstream) beyond the railroad grade of the Kankakee Valley.
0.1	49.5	View to left (northeast and upstream) shows north valley wall.

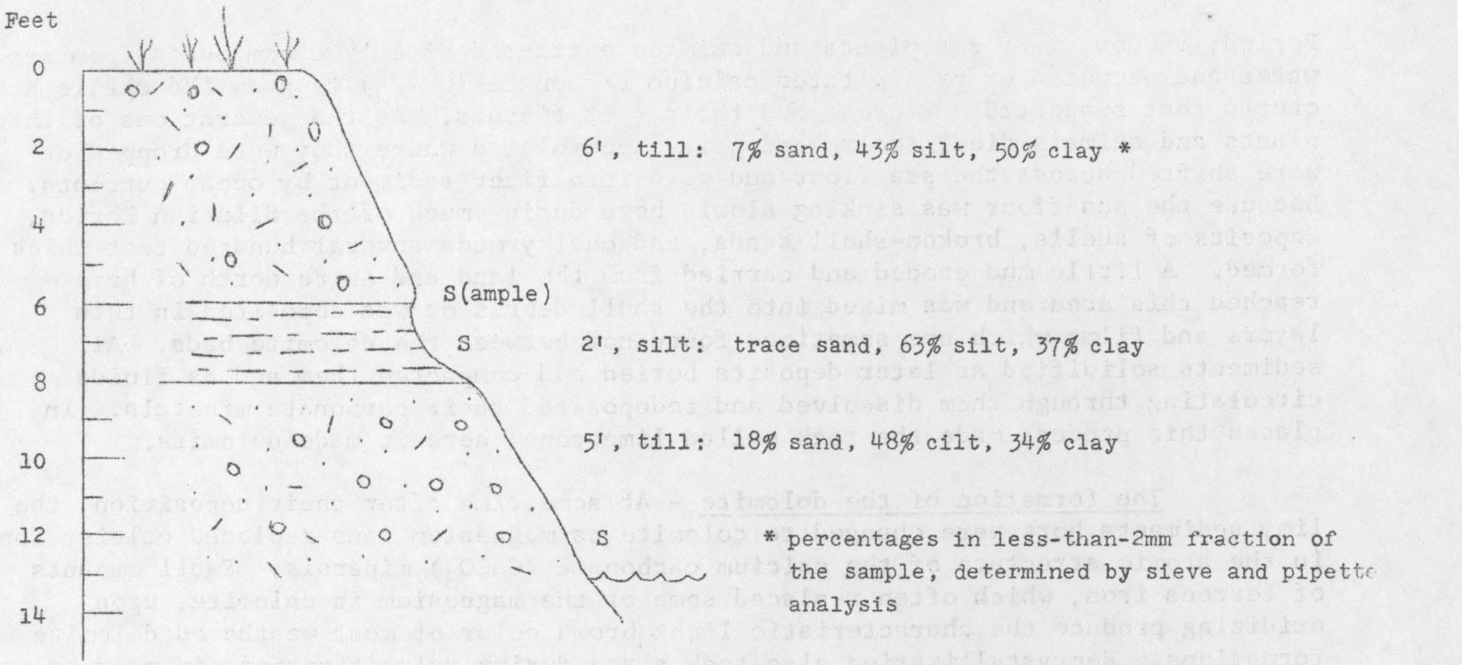


Fig. 8 - Exposure at Highway 17 curve.

0.25 49.75 CAUTION - narrow bridge.

0.4 50.15 CAUTION - T-road from left. TURN LEFT (east) and cross culvert.

0.6 50.75 To left (north) is a good view of the north valley wall. The crest of the uplands to the north is about 70 feet above road level here.

0.9 51.65 T-road from right. TURN RIGHT (south).

0.05 51.7 STOP - intersection with blacktop road at curve. CONTINUE AHEAD (south) with CAUTION.

0.15 51.85 Stop 8. Office of Momence Quarry, Lehigh Stone Operations, Western Materials Company. (SW¼SW¼NW¼NE¼ Sec. 11, T. 31 N., R. 14 E., Kankakee County, Momence 15-minute quadrangle.)

A thickness of about 24 to 30 feet of dolomite is exposed in the quarry. The rock is identified as part of the Racine Formation of Silurian age (see figures 1 and 2). The dolomite has a fine to medium crystalline texture (the crystals appear to range in size from less than 1/16mm to about 1/4mm). The tiny, sharp-cornered dolomite crystals give the rock its sandpaper-like feel and its fine glitter. The dolomite contains a small quantity of quartz silt (which is hard to see in the rock).

The lower three-fourths of the exposure is light olive gray. The upper fourth is the same rock, but penetrated by weathering from the ground surface which has changed its color to pale yellow, left rust brown stains along partings and cracks in the rock, and decomposed it into 3- to 6-inch flaggy (like flagstones) beds. The lower half of the wall is composed of massive beds up to 3 feet thick. The thin partings which separate these beds are stylolite seams.

Origin of these sediments - The dolomites at the surface of the field trip area are largely composed of the remains of sea life. During the Silurian

Period, as now, many sea plants and animals extracted dissolved compounds from sea water and secreted or precipitated calcium carbonate ($CaCO_3$) to grow the shells and crusts that supported and protected their soft tissues. As the generations of these plants and animals died, their hard parts accumulated where they were dropped or were shifted across the sea floor and worn into finer sediment by ocean currents. Because the sea floor was sinking slowly here during much of the Silurian Period, deposits of shells, broken-shell sands, and chalky muds several hundred feet thick formed. A little mud eroded and carried from the land and shore north of here reached this area and was mixed into the shell debris or was deposited in thin layers and films which are sometimes found now between the dolomite beds. All sediments solidified as later deposits buried and compacted them and as fluids circulating through them dissolved and redeposited their carbonate minerals. In places this process made the rock called limestone; here it made dolomite.

The formation of the dolomite - At some time after their deposition, the limy sediments here were changed to dolomite as magnesium ions replaced calcium ions in the atomic structure of the calcium carbonate ($CaCO_3$) minerals. Small amounts of ferrous iron, which often replaced some of the magnesium in dolomite, upon oxidizing produce the characteristic light brown color of most weathered dolomite formations. Recrystallization also took place during dolomitization, in many cases producing the sucrosic (sugary) texture that is a characteristic of many dolomites. When dolomite crystals replaced calcium carbonate crystals, primary sedimentary textures and structures, such as current features and fossil remains, were often destroyed or, at best, were poorly preserved. The question of how and why the dolomites formed has not been satisfactorily answered.

Collecting at this quarry - The pale yellow slabs contain many snail, large brachiopod, and coral fossils. The penetration of weathering in this zone has revealed the fossils. PLEASE DO NOT WORK ON OR CLOSE TO THE PIT WALLS. Blocks are apt to fall from shattered walls. Specimens are more abundant and easier to collect from the piles of broken stone down in the pit.

END OF TRIP - HAVE A SAFE JOURNEY HOME!

PLEISTOCENE GLACIATIONS IN ILLINOIS

Origin of the Glaciers

During the past million years or so, the period of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. Ice sheets formed in sub-arctic regions four different times and spread outward until they covered the northern parts of Europe and North America. In North America the four glaciations, in order of occurrence from the oldest to the youngest, are called the Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. The limits and times of the ice movement in Illinois are illustrated in the following pages by several figures.

The North American ice sheets developed during periods when the mean annual temperature was perhaps 4° to 7° C (7° to 13° F) cooler than it is now and winter snows did not completely melt during the summers. Because the cooler periods lasted tens of thousands of years, thick masses of snow and ice accumulated to form glaciers. As the ice thickened, the great weight of the ice and snow caused them to flow outward at their margins, often for hundreds of miles. As the ice sheets expanded, the areas in which snow accumulated probably also increased in extent.

Tongues of ice, called lobes, flowed southward from the Canadian centers near Hudson Bay and converged in the central lowland between the Appalachian and Rocky Mountains. There the glaciers made their farthest advances to the south. The sketch below shows several centers of flow, the general directions of flow from the centers, and the southern extent of glaciation. Because Illinois lies entirely in the central lowland, it has been invaded by glaciers from every center.

Effects of Glaciation

Pleistocene glaciers and the waters melting from them changed the landscapes they covered. The glaciers scraped and smeared the landforms they overrode, leveling and filling many of the minor valleys and even some of the larger ones. Moving ice carried colossal amounts of rock and earth, for much of what the glaciers wore off the ground was kneaded into the moving ice and carried along, often for hundreds of miles.

The continual floods released by melting ice entrenched new drainageways, deepened old ones, and then partly refilled both with sediments as great quantities of rock and earth were carried beyond the glacier fronts. According to some estimates, the amount of water drawn from the sea and changed into ice during a glaciation was probably enough to lower sea level more than 300 feet below present level. Consequently, the melting of a continental ice sheet provided a tremendous volume of water that eroded and transported sediments.

In most of Illinois, then, glacial and meltwater deposits buried the old rock-ribbed, low, hill-and-valley terrain and created the flatter landforms of our prairies. The mantle of soil material and the deposits of gravel, sand, and clay left by the glaciers over about 90 percent of the state have been of incalculable value to Illinois residents.

Glacial Deposits

The deposits of earth and rock materials moved by a glacier and deposited in the area once covered by the glacier are collectively called drift. Drift that is ice-laid is called till. Water-laid drift is called outwash.

Till is deposited when a glacier melts and the rock material it carries is dropped. Because this sediment is not moved much by water, a till is unsorted, containing particles of different sizes and compositions. It is also unstratified (unlayered). A till may contain materials ranging in size from microscopic clay particles to large boulders. Most tills in Illinois are pebbly clays with only a few boulders.

Tills may be deposited as end moraines, the arc-shaped ridges that pile up along the glacier edges where the flowing ice is melting as fast as it moves forward. Till also may be deposited as ground moraines, or till plains, which are gently undulating sheets deposited when the ice front melts back, or retreats. Deposits of till identify areas once covered by glaciers. Northeastern Illinois has many alternating ridges and plains, which are the succession of end moraines and till plains deposited by the Wisconsinan glacier.

Sorted and stratified sediment deposited by water melting from the glacier is called outwash. Outwash is bedded, or layered, because the flow of water that deposited it varied in gradient, volume, velocity, and direction. As a meltwater stream washes the rock materials along, it sorts them by size--the fine sands, silts, and clays are carried farther downstream than the coarser gravels and cobbles. Typical Pleistocene outwash in Illinois is in multilayered beds of clays, silts, sands, and gravels that look much like modern stream deposits.

Outwash deposits are found not only in the area covered by the ice field but sometimes far beyond it. Meltwater streams ran off the top of the glacier, in crevices in the ice, and under the ice. In some places, the cobble-gravel-sand filling of the bed of a stream that flowed in the ice is preserved as a sinuous ridge called an esker. Cone-shaped mounds of coarse outwash, called kames, were formed where meltwater plunged through crevasses in the ice or into ponds along the edge of the glacier.

The finest outwash sediments, the clays and silts, formed bedded deposits in the ponds and lakes that filled glacier-dammed stream valleys, the sags of the till plains, and some low, moraine-diked till plains. Meltwater streams that entered a lake quickly lost speed and almost immediately dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were moved across the lake bottom by wind-generated currents, and the clays, which stayed in suspension longest, slowly settled out and accumulated with them.

Along the ice front, meltwater ran off in innumerable shifting and short-lived streams that laid down a broad, flat blanket of outwash that formed an outwash plain. Outwash was also carried away from the glacier in valleys cut by floods of meltwater. The Mississippi, Illinois, and Ohio Rivers occupy valleys that were major channels for meltwaters and were greatly widened and deepened during times of the greatest meltwater floods. When the floods waned, these valleys were partly filled with outwash far beyond the ice margins. Such outwash deposits, largely sand and gravel, are known as valley trains. Valley trains may be both extensive and thick deposits. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.

Loess and Soils

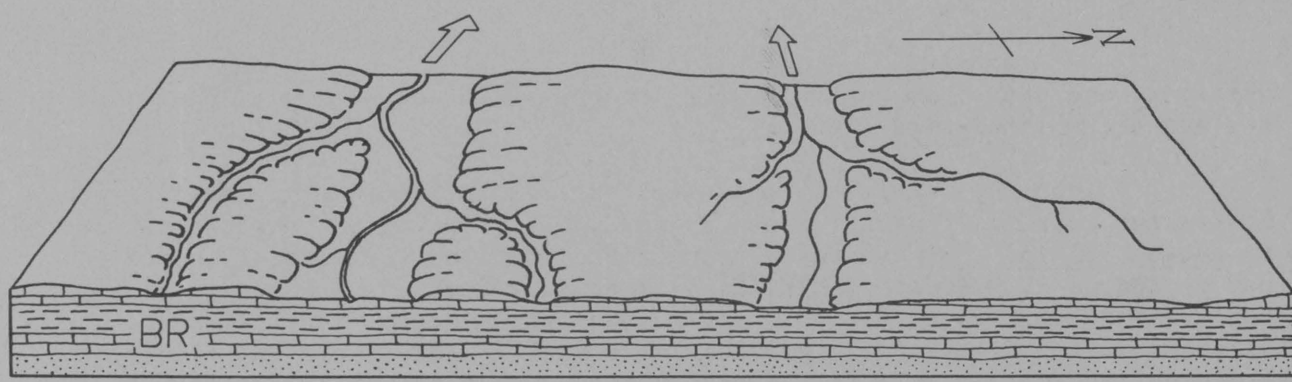
One of the most widespread sediments resulting from glaciation was carried not by ice or water but by wind. Loess is the name given to such deposits of windblown silt and clay. The silt was blown from the valley trains on the floodplains. Most loess deposition occurred in the fall and winter seasons when low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and permitting them to dry out. During Pleistocene time, as now, west winds prevailed, and the loess deposits are thickest on the east sides of the source valleys. The loess thins rapidly away from the valleys but extends over almost all the state.

Each Pleistocene glaciation was followed by an interglacial stage that began when the climate warmed enough to melt the glaciers and their snowfields. During these warmer intervals, when the climate was similar to that of today, drift and loess surfaces were exposed to weather and the activities of living things. Consequently, over most of the glaciated terrain, soils developed on the Pleistocene deposits and altered their composition, color, and texture. Such soils were generally destroyed by later glacial advances, but those that survive serve as keys to the identity of the beds and are evidence of the passage of a long interval of time.

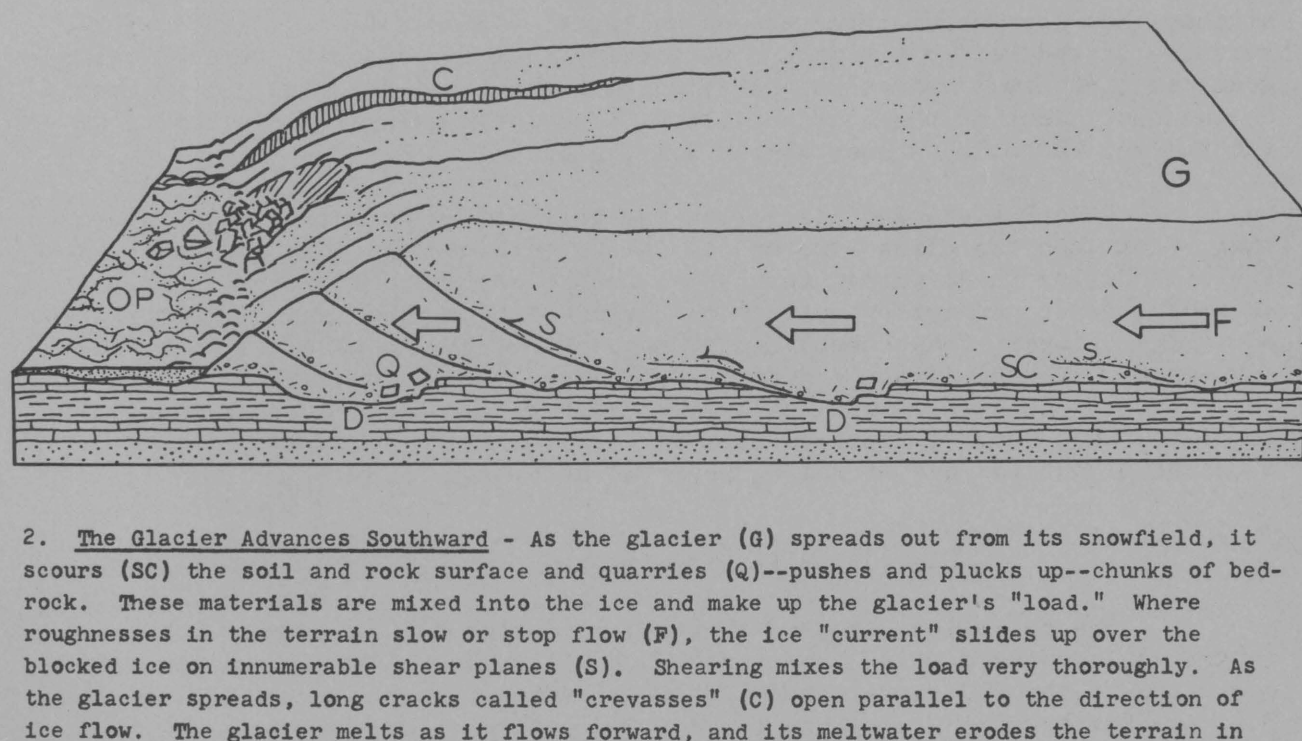
Glaciation in a Small Illinois Region

The following diagrams show how a continental ice sheet might have looked as it moved across a small region in Illinois. They illustrate how it could change the old terrain and create a landscape like the one we live on. To visualize how these glaciers looked, geologists study the landforms and materials left in the glaciated regions and also the present-day mountain glaciers and polar ice caps.

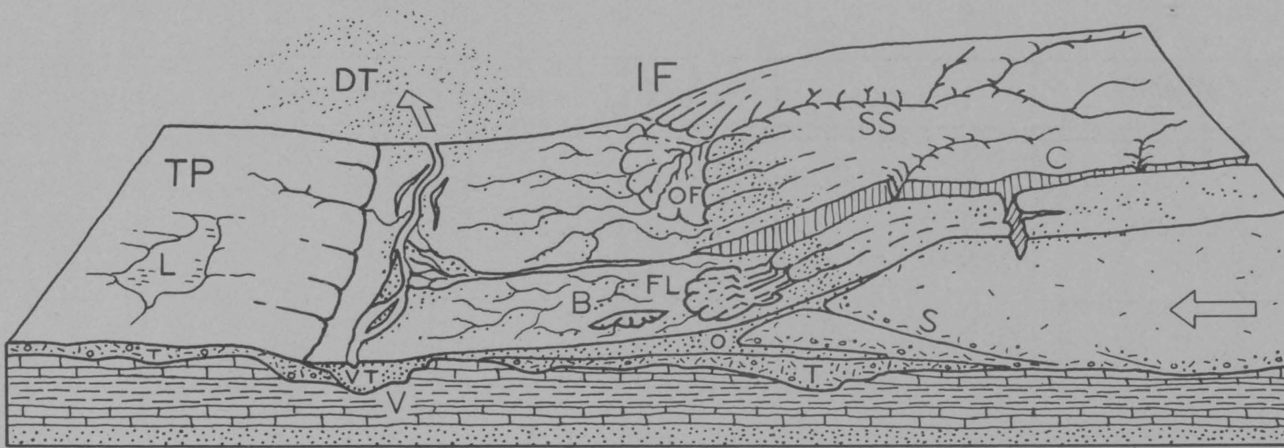
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated--layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



1. <u>The Region Before Glaciation</u> - Like most of Illinois, the region illustrated is underlain by almost flat-lying beds of sedimentary rocks--layers of sandstone ( ), limestone ( ), and shale ( ). Millions of years of erosion have planed down the bedrock (BR), creating a terrain of low uplands and shallow valleys. A residual soil weathered from local rock debris covers the area but is too thin to be shown in the drawing. The streams illustrated here flow westward and the one on the right flows into the other at a point beyond the diagram.



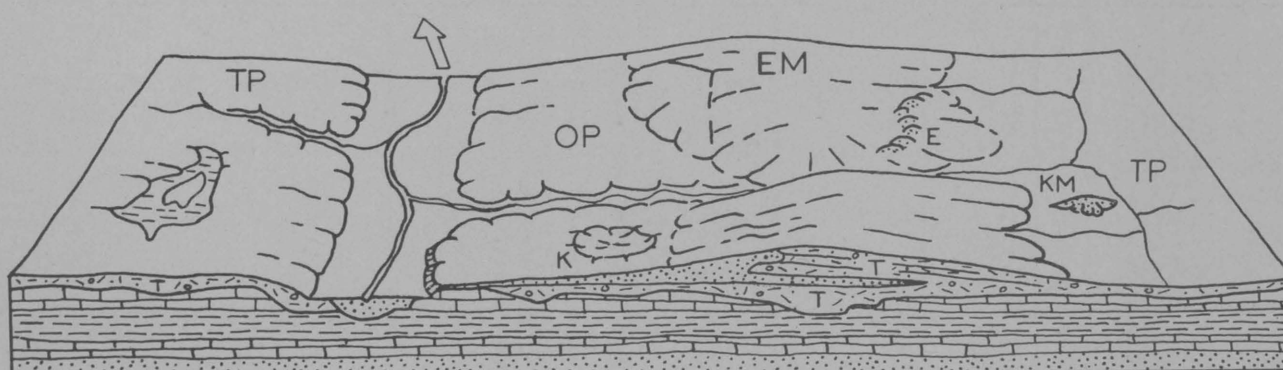
2. <u>The Glacier Advances Southward</u> - As the glacier (G) spreads out from its snowfield, it scours (SC) the soil and rock surface and quarries (Q)--pushes and plucks up--chunks of bedrock. These materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or stop flow (F), the ice "current" slides up over the blocked ice on innumerable shear planes (S). Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" (C) open parallel to the direction of ice flow. The glacier melts as it flows forward, and its meltwater erodes the terrain in front of the ice, deepening (D) some old valleys before the ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain (OP). The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick , except near its margin. Its ice front advances perhaps as much as a third of a mile per year.



3. The Glacier Deposits an End Moraine - After the glacier advanced across the area, the climate warmed and the ice began to melt as fast as it advanced. The ice front (IF) is now stationary, or fluctuating in a narrow area, and the glacier is depositing an end moraine.

As the top of the glacier melts, some of the sediment that was mixed in the ice accumulates on top of the glacier. Some is carried by meltwater onto the sloping ice front (IF) and out onto the plain beyond. Some of the debris slips down the ice front in a mudflow (FL). Meltwater runs through the ice in a crevasse (C). A superglacial stream (SS) drains the top of the ice, forming an outwash fan (OF). Moving ice has overridden an immobile part of the front on a shear plane (S). All but the top of a block of ice (B) is buried by outwash (O).

Sediment from the melted ice of the previous advance (figure 2) was left as a till layer (T), part of which forms the till plain (TP). A shallow, marshy lake (L) fills a low place in the plain. Although largely filled with drift, the valley (V) remained a low spot in the terrain. As soon as its ice cover melted, meltwater drained down the valley, cutting it deeper. Later, outwash partly refilled the valley--the outwash deposit is called a valley train (VT). Wind blows dust (DT) off the dry floodplain. The dust will form a loess deposit when it settles.



4. The Region after Glaciation - The climate has warmed even more, the whole ice sheet has melted, and the glaciation has ended. The end moraine (EM) is a low, broad ridge between the outwash plain (OP) and till plains (TP). Run-off from rains cuts stream valleys into its slopes. A stream goes through the end moraine along the channel cut by the meltwater that ran out of the crevasse in the glacier.

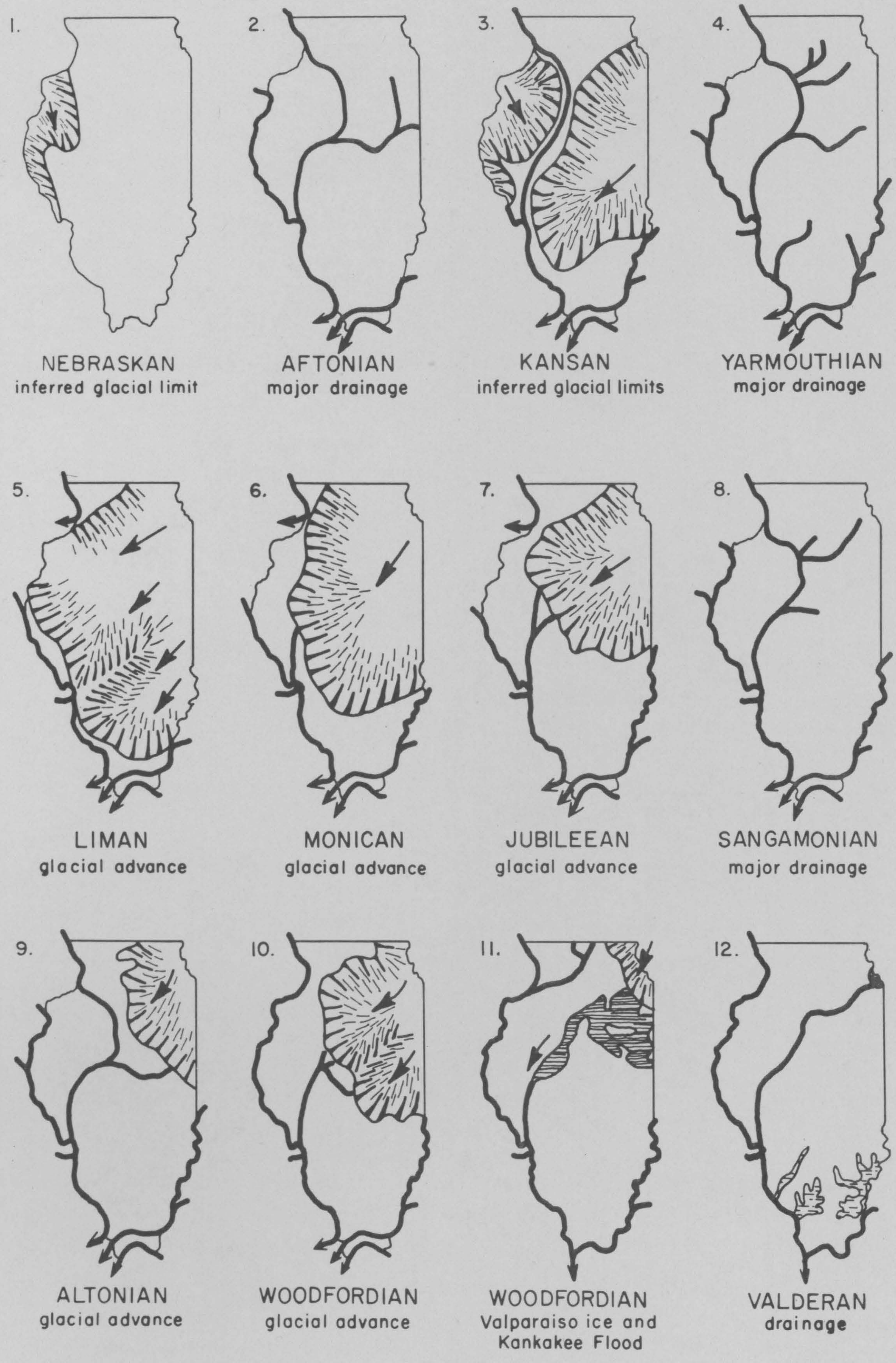
Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel into a crevasse or other depression in the glacier or at its edge is a kame (KM). A few feet of loess covers the entire area but cannot be shown at this scale.

TIME TABLE OF PLEISTOCENE GLACIATION

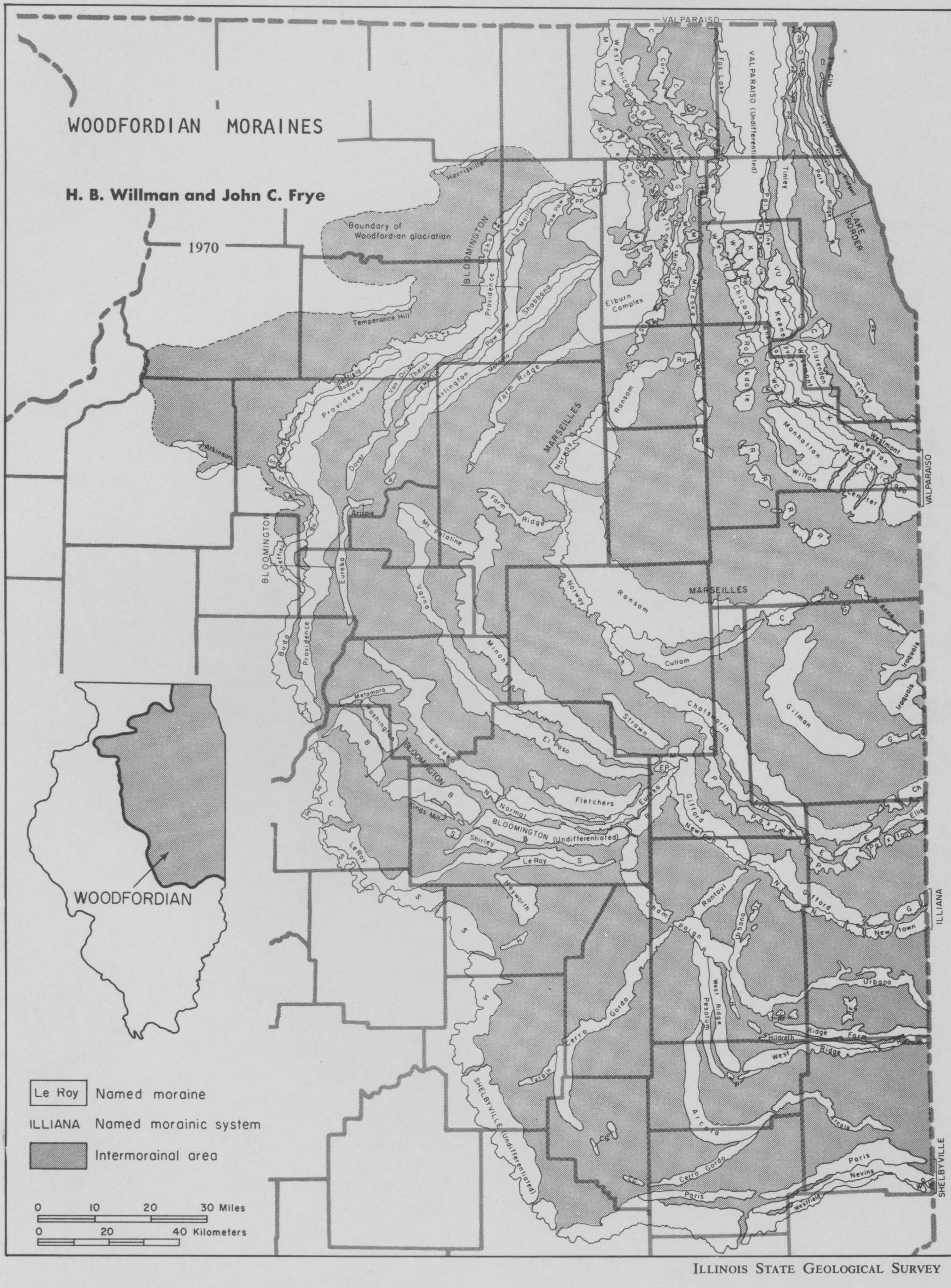
STAGE	SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
HOLOCENE	Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
	7,000		
	Valderan	Outwash, lake deposits	Outwash along Mississippi Valley
	11,000		
	Twocreekan	Peat and alluvium	Ice withdrawal, erosion
	12,500		
WISCONSINAN (4th glacial)	Woodfordian	Drift, loess, dunes, lake deposits	Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes
	22,000		
	Farmdalian	Soil, silt, and peat	Ice withdrawal, weathering, and erosion
	28,000		
	Altonian	Drift, loess	Glaciation in northern Illinois, valley trains along major rivers
	75,000		
SANGAMONIAN (3rd interglacial)		Soil, mature profile of weathering	
	175,000		
ILLINOIAN (3rd glacial)	Jubileean Monican Liman	Drift, loess Drift, loess Drift, loess	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
	300,000		
YARMOUTHIAN (2nd interglacial)		Soil, mature profile of weathering	
	600,000		
KANSAN (2nd glacial)		Drift, loess	Glaciers from northeast and northwest covered much of state
	700,000		
AFTONIAN (1st interglacial)		Soil, mature profile of weathering	
	900,000		
NEBRASKAN (1st glacial)		Drift	Glaciers from northwest invaded western Illinois
	1,200,000 or more		

(Illinois State Geological Survey, 1973)

SEQUENCE OF GLACIATIONS AND INTERGLACIAL
DRAINAGE IN ILLINOIS



(From Willman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)


WOODFORDIAN MORAINES
H. B. Willman and John C. Frye
1970
VALPARAISO
VALPARAISO (Undifferentiated)
LAKE BORDER
BLOOMINGTON
MARSEILLES
BLOOMINGTON (Undifferentiated)
SHELBYVILLE (Undifferentiated)
ILLIANA
SHELBYVILLE
Boundary of Woodfordian glaciation
Temperance Hill
Harrisville
Elburn Complex
Providence
Shabbona
Farm Ridge
Ransom
Norway
Mt Palatine
Eureka
Varna
Minonk
Cullom
Chatsworth
Gilman
Iroquois
El Paso
Strawn
Fletchers
Normal
Shirley
Le Roy
Gifford
Newtown
Paxton
Rantoul
Champaign
Urbana
West Ridge
Pesotum
Ridge Farm
Hildreth
Cerro Gordo
Arcola
Paris
Nevins
Westfield
Metamora
Washington
Kings Mill
Heyworth
Manhattan
Wilton
Wheaton
Westmont
Clarendon
Tinley
Park Ridge
West Chicago
Fox Lake
Rockdale
Minooka
St. Charles
Marengo
Sheffield
Buda
Dover
Atkinson
WOODFORDIAN
Le Roy Named moraine
ILLIANA Named morainic system
Intermorainal area
0 10 20 30 Miles
0 20 40 Kilometers

ILLINOIS STATE GEOLOGICAL SURVEY

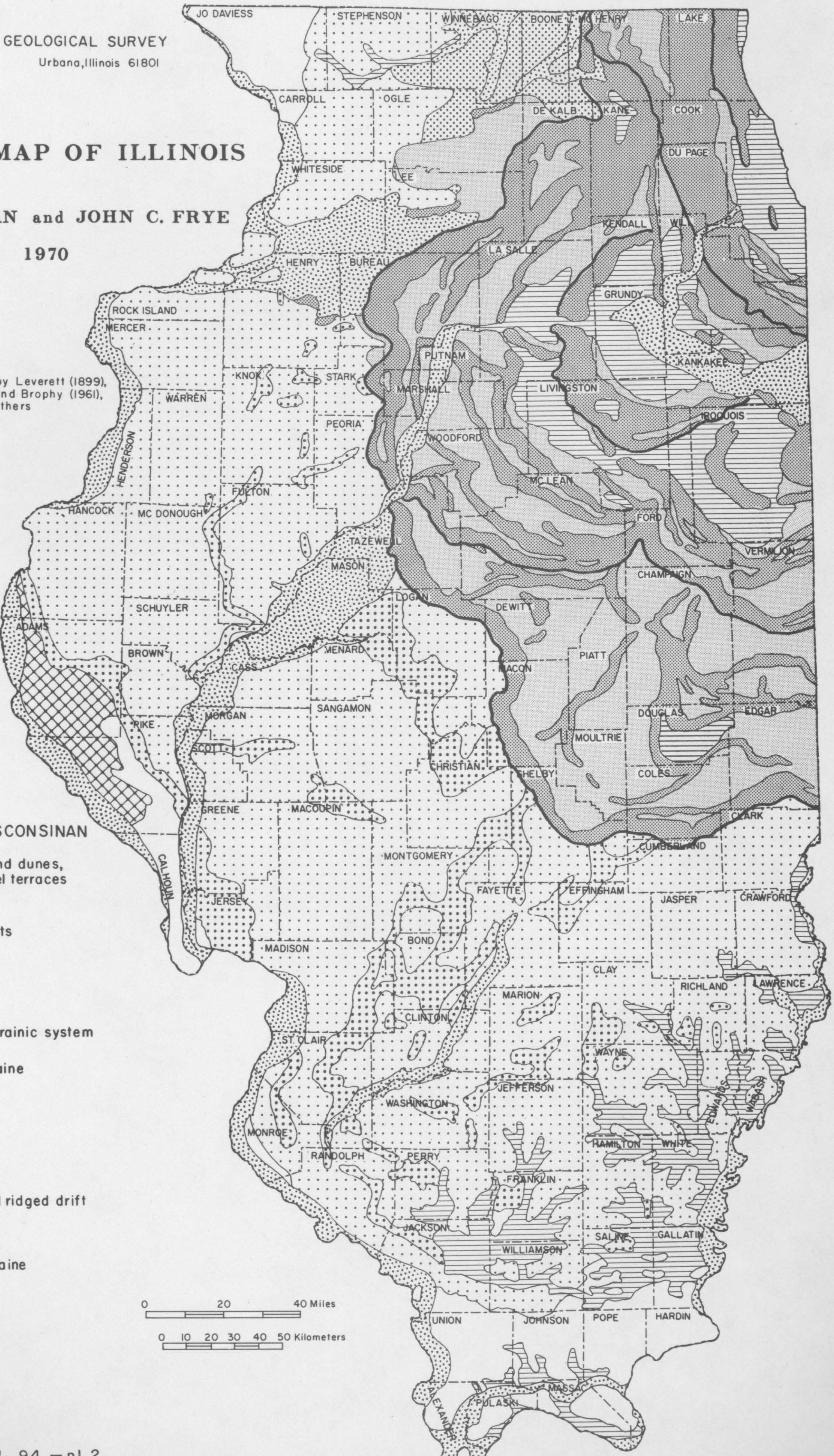
John C. Frye, Chief Urbana, Illinois 61801

GLACIAL MAP OF ILLINOIS

H.B. WILLMAN and JOHN C. FRYE

1970

Modified from maps by Leverett (1899), Ekblaw (1959), Leighton and Brophy (1961), Willman et al. (1967), and others



EXPLANATION

HOLOCENE AND WISCONSINAN

Alluvium, sand dunes, and gravel terraces

WISCONSINAN

Lake deposits

WOODFORDIAN

Moraine

Front of morainic system

Groundmoraine

ALTONIAN

Till plain

ILLINOIAN

Moraine and ridged drift

Groundmoraine

KANSAN

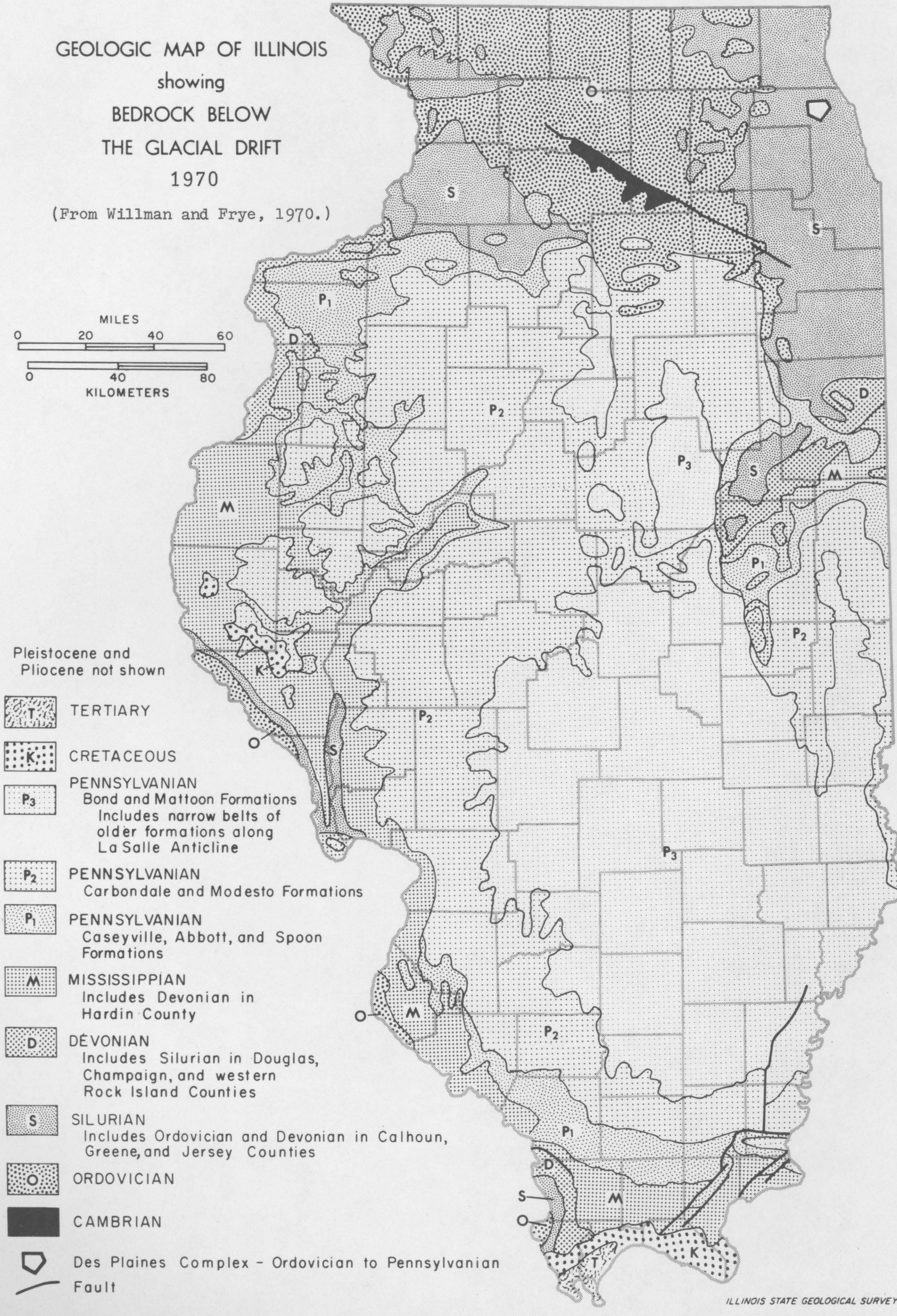
Till plain

DRIFTLESS

Modified from Bull. 94.—pl. 2

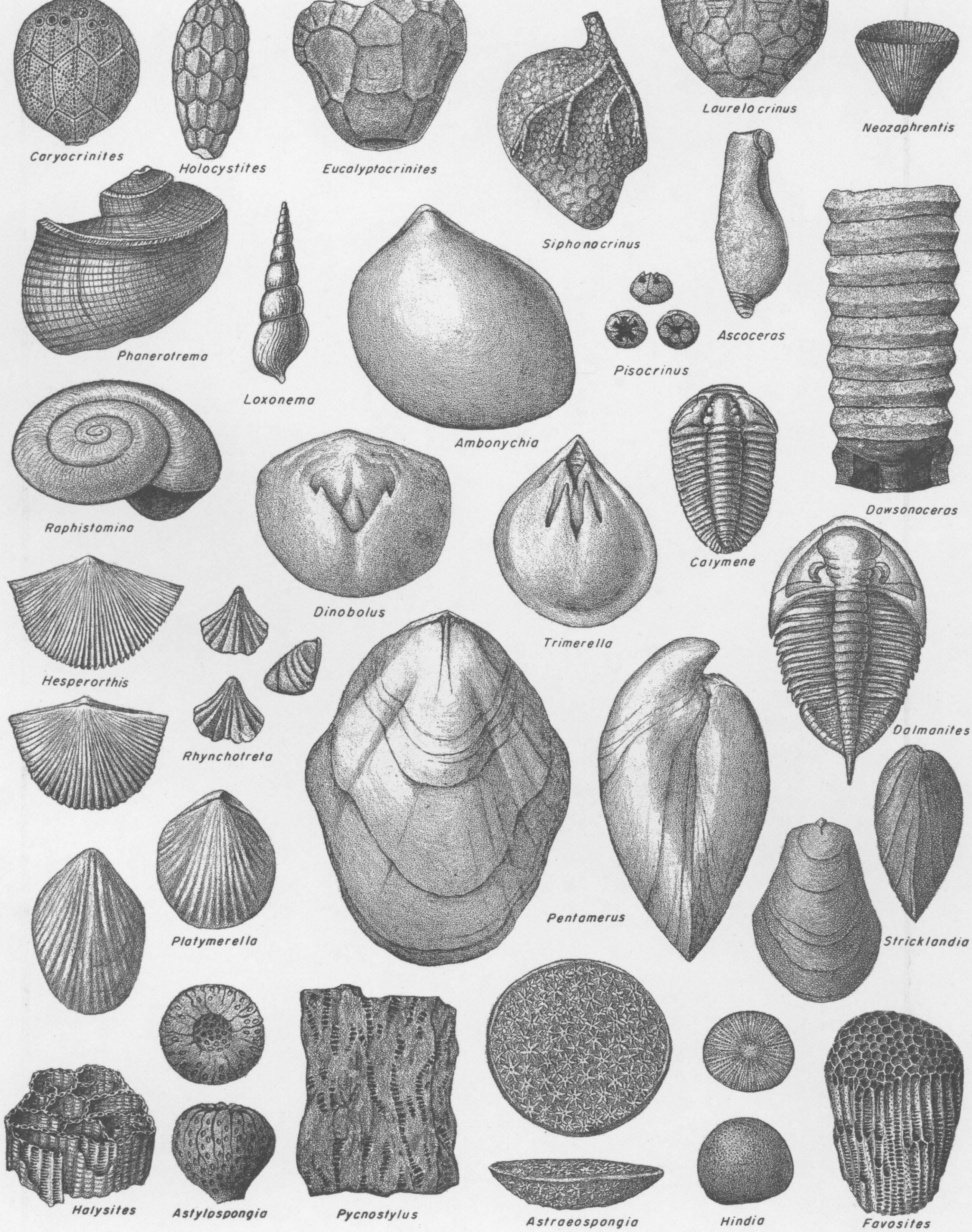
GEOLOGIC MAP OF ILLINOIS
showing
BEDROCK BELOW
THE GLACIAL DRIFT
1970

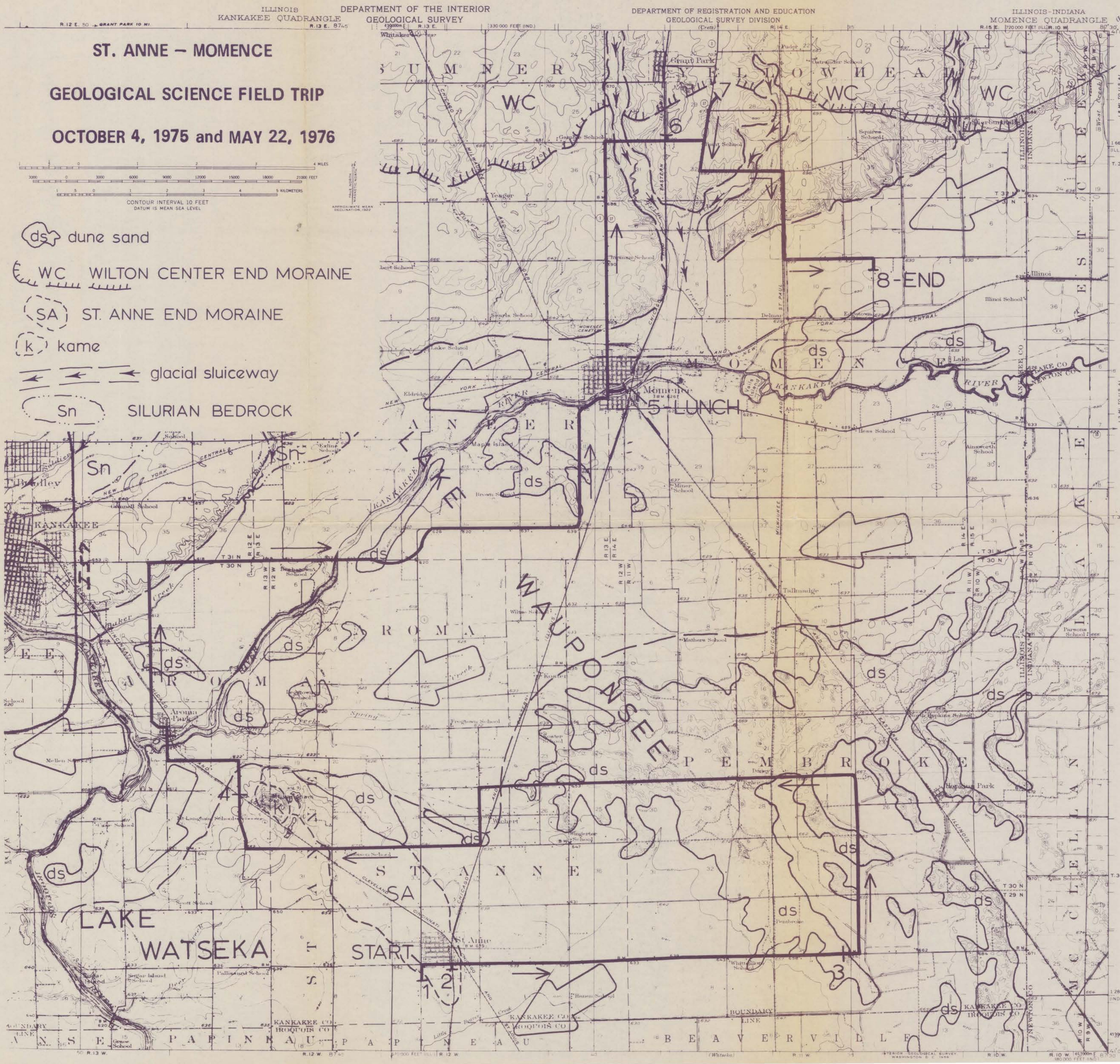
(From Willman and Frye, 1970.)



ILLINOIS STATE GEOLOGICAL SURVEY

REPRESENTATIVE SILURIAN FOSSILS FROM NORTHWESTERN ILLINOIS




ST. ANNE – MOMENCE
GEOLOGICAL SCIENCE FIELD TRIP
OCTOBER 4, 1975 and MAY 22, 1976
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL
ds dune sand
WC WILTON CENTER END MORAINE
SA ST. ANNE END MORAINE
k kame
glacial sluiceway
Sn SILURIAN BEDROCK
ILLINOIS
KANKAKEE QUADRANGLE
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
DEPARTMENT OF REGISTRATION AND EDUCATION
GEOLOGICAL SURVEY DIVISION
ILLINOIS-INDIANA
MOMENCE QUADRANGLE
START
1
2
3
4
5-LUNCH
6
7
8-END
LAKE WATSEKA
LAKE WAUPONSEE
SUMNER
YELLOWHEAD
MOMENCE
GANEER
AROMA
PEMBROKE
ST. ANNE
PAPINEAU
BEAVERVILLE
WEST CREEK
LAKE
MC CLELLAN
Grant Park
Momence
St. Anne
Kankakee
Bradley
Aroma Park
Hopkins Park
Tallmadge
KANKAKEE RIVER
KANKAKEE CO
IROQUOIS CO
ILLINOIS
INDIANA
T. 32 N.
T. 31 N.
T. 30 N.
T. 29 N.